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THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

EDUCATION OF THE PROFESSIONAL CHEMIST[1]

IN conforming to the time-honored custom of presenting an address as retiring chairman of Section C, it occurred to me that I might not select a subject more worthy of thoughtful consideration than the education of the professional chemist. In view of the fundamental changes in conditions throughout the commercial world, affecting educational institutions by bringing forward aspects of mental training and practical applications that have no precedents in our earlier experience, it is certainly essential that this influence on modern progress receive critical attention. The recent excellent papers expressing the views of eminent teachers and practical chemists on suitable requirements for the training of young men in chemistry have ably presented the various aspects of this important subject. Yet I have thought that the last word has not been said concerning certain features of professional education, especially relating to the mental attitude of the student, and of the embryo chemist about to enter business life. It can not be doubted that the courses offered by schools of science deserve all the attention they have received in the form of suggestions and criticisms, particularly from the experience of older graduates gained in close touch with great operations in the industrial world. The

[1] Address of the vice-president and chairman of Section C, New York meeting, December, 1906.

term professional chemist is suggested to include the chemical engineer, the engineering chemist, the expert and the consulting chemist.

Even those of us who have been actively occupied in the broad field of chemistry as teachers or professional workers during the last quarter or third of the century, find it difficult to realize the great transition within this period. It is inevitable that the all-pervading commercial spirit of our generation should be felt in institutions of learning, perhaps more forcibly in schools of science, where students have an immediate prospect of seeking their fortunes in the absorbing vortex of business activity. The benefits that have come to those institutions as one result of the recent unparalleled industrial and business expansion have been accompanied by certain disturbing influences that are difficult of control. With such a golden flow into the educational coffers, new institutions have grown to large proportions like the traditional mushroom, and the older ones have doubled or quadrupled in capacity and power.

Naturally, every student within college walls has his attention attracted to the courses of wealth which provide these great benefactions. It suggests a possibility of a similar pecuniary reward even to the extent of limiting his interest to subjects and their especial features that shall in his estimation lead to immediate advancement and profit on his exit from the collegiate environment. I believe I am stating a part of the common experience of teachers, with reference to the mental attitude of a considerable proportion of the student body. Impatient of attainment along the lines of self-improvement and broad culture, the student regards his institution merely as an influence in gaining an initial foothold, satisfied with the minimum requirements that it will accept for his respectable graduation. I do not wish to express the belief that this feeling is universal, but it is sufficiently evident both as to outward expression on the part of some, and through the influence of association on the part of many, to interfere seriously with the highest ideals of intellectual training. It tends to limit the efforts of teachers to a monotonous routine, and the maintenance of an acceptable standing of students in this routine.

It can not be doubted that the conditions of instruction in the highest institutions may be greatly improved by certain changes in the secondary schools. Much has been done within the last few years mainly with the aid and cooperation of teachers in the higher institutions; but the suggestions for better work in chemistry have been limited rather to improvement in methods already in use than to fundamental changes to eliminate primary causes. Judging from the results of entrance examinations, the pupil is taught a text-book rather than chemistry, a fatal error with young pupils, for when they once begin to depend on the printed page, their vision of what they should learn is obscured by their false support. Observation of natural facts should be the only guide until the pupil has a sufficiently well-grounded method to enable him to distinguish between his own observation and printed descriptions. On account of the inherent inertia of young pupils and their inclination to lean on the teacher or the text-book, it is not safe to permit the use of a book until they have acquired a good knowledge of facts and deductions.

Why chemistry should be relegated to the fourth year of the high school, and then suddenly launched on the pupil as a full-fledged science, usually prefaced, as in the ordinary text-book, with a series of definitions and a statement of theoretical principles, almost before the correct obser-

vation of a single fact, it is difficult to understand. I believe the reason usually suggested is that chemistry can not be taught to immature pupils of the lower grades. With the text-books at present in use, I appreciate the force of this suggestion, and it applies with the same weight to the grade to which it is introduced, the third or fourth year of the high school. At the age of most susceptible inquiry the child is in an environment in which he is constantly confronted with chemical changes, yet he is permitted to know nothing even of the air he breathes, or the water he drinks, except that the former is hot or cold, and that the latter quenches thirst, until he reaches the age of fifteen or sixteen years. At this period, having spent one third or more of his time on arithmetic and higher mathematics, and the remainder in text-book drill on other subjects, his mind has lost to a large extent the elasticity of earlier years, and he naturally attacks any new subject by the same routine methods. It may easily be demonstrated that correct habits of observation and inference in chemistry and certain elementary facts that every person should know can be taught in the grammar grade. The pupil whose school life terminates with the grammar school may demand as his due that he shall receive such instructions. His capacity is fully equal to it; it is necessary with whatever department of business he may be connected; it is one of the most important elements of his education. Why should he not have it? No extensive laboratories are needed; no expensive apparatus. The expense is but a trifle. But it does demand the teacher; one who can put aside the text-book, and present chemical changes from nature's standpoint; one who has the aptitude to lead the youthful mind from the simple observations of every-day life to less obvious chemical changes, until before the pupil is aware of it he has acquired the habit of thought essential to the proper study of elementary chemistry. I grant that the latter requirement is the most difficult of all; but it is one of the pressing needs to place instruction in the grammar grade on a sensible basis; teachers properly trained to teach the elementary facts of nature. With such a foundation the high-school course may be made more effective, and it should then properly be assigned to the maturer years. It should include a comprehensive study of facts and elementary reasoning, but with limited theoretical conceptions, which should be left to the broader courses of the higher institutions.

Teachers of large experience who are fortunately in touch with the details of manufacture in large plants, have a vivid sense of the marvelous expansion that is in progress all over the world and especially in our own country. While the practical chemist must know something of all the important branches of manufacture, it is beyond his capacity to acquire a working knowledge of more than a limited range of processes, and to keep pace with the advance in improvements. The outcome of this situation is the intense specialist, one who not only knows what is common knowledge of his subject, but who has carried his study and application beyond the border. This sort of man is in active and increasing demand; his service is much sought for, and he can command his remuneration. The successful man of business, especially the chemical manufacturer, is of necessity a specialist in his particular field. He is keenly alert in acquiring knowledge of new advances. But in the many ramifications of his business, he often finds himself beyond his depth, and it is here that he appreciates the service of the broadly trained man. As never before, successful manufacturing operations

are dependent on the application of scientific principles in a scientific manner. Such a position promises most to the young chemist, and the sooner he comprehends its possibilities the more rapid will be his promotion. When he steps out into the great school of active life, so far as his practical knowledge of details are concerned, he should understand in all modesty that he must begin at the lowest round of the ladder. While gaining his business experience and patiently waiting for the opportunities, which will not be long delayed, when his scientific attainments shall be called into service, he will escape the criticism frequently made by manufacturers that the young graduate is apt to assume a grasp of practical details that he has not acquired.

Most manufacturers have a high respect for the advantages afforded by scientific education, and are ready to receive the young graduate with open cordiality, expecting service that they stand in need of. With too great confidence in his grasp of practical details, often the manufacturer assigns duties involving business experience which the young man has yet to gain, with disappointing results. In thus rashly undertaking such work he not only brings discredit on himself, but arouses a feeling of distrust concerning the practical utility of scientific training in general.

It may, perhaps, be said of the professional chemist that his career depends in no small degree on ancestral inheritance. I am inclined to the belief that this is true with reference not only to inborn energy and ability without which the best success is not possible in any direction, but especially to a certain inherent quick perception and logical turn of mind, that many persons do not possess and can never acquire. Certain it is that no amount of training can produce a successful chemist out of an individual who lacks these essential qualities. An extended experience in fitting young men for employment in chemistry leads, I think, to the conviction that it is not a large proportion of the average body of students that have the peculiar mental poise and manual dexterity to become successful chemists in a broad sense. As to what should be regarded as success, pecuniary compensation may in general be accepted as a measure of ability, although many men in responsible positions will not accept such a standard since they feel that their service is not recognized in proportion to the profits they help to accumulate in the business treasury. Generally speaking, however, with the unprecedented demand for good men, ability is well compensated. With respect to young men just gaining a foothold there is evidence that their service is appreciated. Statistics have recently been collected from graduates of five years' standing from Case School of Applied Science in all departments, with reference to what salaries would induce them to accept other positions on the basis of what they are now receiving. The average in chemistry was $3,000. After ten or fifteen years of service, I have reason to believe that salaries of professional chemists equivalent to $5,000 and $10,000 a year are not uncommon. While the standard of pecuniary compensation is not unreasonable from the point of view of the man of business, who looks on his ledger balance at the end of the year as a measure of success, the professional chemist seeks also a higher reward. He can not sever his mental connection from the profound truths of nature, and the more he struggles for the mastery and utilization of those truths, the deeper becomes his reverence for the immutable laws that control and direct his efforts. He is constantly under the stimulating influence of new discovery and an expanding field of usefulness. It

is, perhaps, unnecessary to suggest that this does not apply to the man who is content with a daily routine, with no connections outside of his laboratory walls, but, as mentioned above, to one who is equal to present demands; who is alive to the advance of knowledge in his particular field the world over; who is able to keep in touch with new applications and new processes, and to apply them with discretion. To such a man, imbued with the spirit of research and the instinct of successful application, the best reward for unselfish effort is its appreciation from the point of view of professional standing, which even the manufacturer, after he is assured that the ledger balance is satisfactory, is eagerly ready to recognize.

An incidental advantage to the professional chemist, one of the features of his education, is the readiness with which he is able to grasp the essential principles of business operations. I have been impressed by the frequent expressions from older graduates as to their feeling of indebtedness to a chemical education for success in the application of business methods. They recognize the fact that the close observance in experimental study, constant exercise in inductive reasoning, and the consequent truthful attitude of mind, the directive forces in the study of chemistry, establish in the individual the habit of looking at all matters that concern him from a similar point of view.

If this be the situation that confronts the young graduate when he enters business life, what shall be his preparation for the duties that await him? What is the responsibility of the institution that sends him forth? First of all, he must be a well-balanced man physically and mentally, alert to the individual duties of life. The best success in any department of activity depends primarily on the service of a well-nourished, healthy body, and such health and strength is dependent on the observance of correct habits of bodily attention and nutrition, established in early youth. During the critical period of school and collegiate training, it is imperative that the excessive mental strain be supported by systematic physical exercise, or the individual will suffer. It is incumbent on an educational institution to provide suitable physical exercise and to require it of every student. Man is a creature of habit, and correct habits early formed are more readily observed in later life.

In the technical preparation for professional employment, as suggested above, the education in chemistry should begin in early years in the grammar grade; correct habits of observation and reasoning should be made a part of the youthful mental equipment. In the higher institution, without interfering with the time devoted to strictly professional studies, sufficient time should be allotted to language and literature, history, philosophy and economics, to impart breadth of thought and to supplement the culture of the science courses. I am not in sympathy with the thought sometimes expressed that science and science studies do not contain the elements of culture. On the contrary, I believe that the best culture is derived from the proper study of physical science. Why should it not be? Is it reasonable to assume that all culture is limited to the study of man with his imperfections, and his works, what he has been, what he has done, excluding the perfect laws of his environment, the universe? It is evidently true that science courses alone do not lead the student to broad conceptions of his duty to society and his relations to the community, unless they are supplemented by courses, as suggested, in other departments of learning.

In the training of the professional

chemist, two facts should be kept in view. Primarily, he must understand chemical changes. Secondly, he must have the ability to devise and operate machinery and appliances in which chemical changes are to be applied on a manufacturing scale. It would seem that the tendency in some of the modern courses in chemical engineering is to give too great prominence to the engineering features at the expense of time that should be devoted to chemistry, with the production of neither an engineer nor a chemist. There is not time in a course of four years to make a good chemist and a finished engineer in the same individual; neither is it possible to make a good chemist without sufficient time and attention for comprehensive training in chemistry. But it is possible to make a good chemist and to allow him adequate time to gain such knowledge of the engineering features as will give him a good foundation for expansion when he enters the factory. In all departments of business the individual who has learned how to do things himself is best fitted to direct the efforts of others; the superintendent who can saw off a board by the square or set a post straight and true, can instantly see whether another is doing his duty. The broadly trained chemist must, therefore, have had practise in handling tools, in working wood and iron; he needs the elements of contruction, of machine design. He must understand the economic production and application of power from different sources. An important part of his equipment is the nature and manipulation of electrical currents and machinery. Such breadth of knowledge may be gained in courses on shop practise, thermodynamics, applied mechanics, heat and steam, hydraulics and machine construction, attendance on courses in electricity with laboratory practise.

In this connection the recurring question of adequate time in the ordinary course may be satisfactorily answered by the tendency in most institutions to extend the limits of practical work. In Case School of Applied Science, the entire month of June is given up to laboratory and field work as a practise term, which adds about one year of practical study to the course of four years. The student is under constant supervision, with sufficient oral instruction to keep him intelligently occupied. Continuous laboratory practise accomplishes very much more that the interrupted hours of the other terms. In answer to the possible objection that it is some infringement on the time for lectures and recitations, it is true that two or three weeks a year are lost to these exercises; but what is gained in practical application in chemistry makes it about equivalent to a course of five years, and the average student is easily able to accomplish the work mentioned above in mechanics and electricity. Indeed, before this recent change in the additional time devoted to the laboratory, our best students and even those of average ability by dint of hard work were able to finish this course. With no sacrifice, therefore, of necessary training in chemistry, the student receives what is needful when he enters on the practise of his profession. Such a course may be designated as engineering chemistry, in which the student becomes primarily a chemist.

To acquire an adequate grasp of foundation principles in chemistry it is necessary to include thorough comprehensive courses in general, inorganic, analytical, theoretical and physical, and organic chemistry, with much time devoted to laboratory work. This routine is practically the same in all institutions, with increasing attention to experimental physical chemistry. It seems scarcely necessary to allude to the subsidiary subjects: English, modern lan-

guages, mathematics, including calculus, descriptive geometry and drawing, physics, mineralogy, elementary use of surveying instruments, and metallurgy, without which a course in engineering chemistry could not be regarded as complete. The increasing importance of bacteriology in the fermentation industries and sanitary chemistry, render it indispensable that the student have some practise in the manipulation of bacteria, and general use of the microscope. He must understand the composition, methods of analysis, valuation and uses of solid liquid and gaseous fuels, and the methods of heating and lighting. In the work of the fourth year, it is essential that the student be led to some extent at least out of the routine of the previous years, to develop greater self-reliance, and to be brought into somewhat close touch with chemical literature, to establish the habit of ascertaining what has been done in any special line of work before undertaking it himself. It is important that he gain a clear understanding of the proper methods of attacking new problems and that he appreciate the necessity of depending on his own resources. In the ordinary course of four years the time that can be devoted to such study is much too limited, but it should be insisted on to the fullest possible extent. The atmosphere of the laboratory should have the stimulating influence of original research. If students feel that they have something before them besides the routine courses it keeps them up to their best effort; they quickly perceive the difference between the spirit of an instructor who has no ambition beyond the hourly recitation and that of one imbued with enthusiasm of original study, and eager to impart something of his own impulse.

Since the chief aim is the preparation of the chemist for efficient service in the manufactory, an essential feature of our discussion relates to the method of teaching industrial chemistry. Evidently in a well-balanced course this instruction should be preceded by the routine work of the first three years, general, analytical, physical, and organic chemistry, all of which is a necessary preparation. Since there is at present nearly as great a demand for men in positions where organic chemistry is requisite as in places which concern inorganic processes alone, the student must be well grounded in theoretical and practical organic chemistry, when undertaking industrial chemistry. I have found it an excellent plan to carry along the course of organic industrial chemistry in the same term with lectures and laboratory practise in organic chemistry. Every operation in applied chemistry is so closely attended by physical conditions affecting economic results, it is necessary that attendant conditions of processes be kept constantly before the student. As one of numerous examples that may be suggested, vapor tension, heat of solution, vaporization, specific heat, are closely connected with distillation, solution, crystallization and purification.

The schools of science owe their foundation primarily to the labors of self-educated men, who without the advantages of systematic training have devised and perfected on a business basis the fundamental methods of the factory. In taking up the burden of his forebears the young graduate is expected to extend it with the advance of modern demands. Shall the school of science attempt to duplicate in a miniature fashion the factory methods with suitable machinery and appliances, or shall its efforts be directed toward broad training in fundamental principles with such laboratory applications as are needed to comprehend an expansion to a manufacturing scale? Evidently this question should be considered from several points of view. It

must be remembered that application on a laboratory scale of any manufacturing process in a manner to afford satisfactory results needs more time than can be found for it in the course of four years, unless it be taken as a subject of a thesis when sufficient time may be devoted to a single subject. But general application should include a considerable number of processes. Depending on the nature of the process, not less than two weeks to two months must be exclusively devoted to any important single operation, and the benefit derived is limited mainly to this process. Another serious hindrance is the magnitude of an adequate equipment. A separate plant of two or more buildings is needed, for the dust and dirt of one variety of process could not be tolerated in the cleanly conditions necessary in others. With sufficient equipment a graduate course should afford ample time for such work on a broad plan. Such a course should evidently include a study of details and conditions with reference to possible improvements. It can not be doubted that an adequate equipment in teaching force and plants working in conjunction with manufacturing establishments, and with sufficient endowment for the costly operation, should form the basis for the expansion of a profitable graduate course. A school of science fortunately situated in the midst of a great variety of manufacturing operations has the immense advantage that the manufacturing plants really constitute an important adjunct to its equipment. After thoroughly reviewing the details of a manufacturing process in lectures and recitations, next to actually conducting the operation, the student receives a part of his most valuable experience in inspecting such operation under intelligent guidance during his visits. It is a mutual advantage to the institution and to the manufacturer, for it is an invaluable aid to the courses of instruction in the former, and it insures to the latter a more practical knowledge of processes to the student whom he may later employ.

With the most elaborate experimental preparation, however, the graduate approaches a different atmosphere when he enters the factory where every effort has a pecuniary value. Outside the factory it is not possible to take into account the element of costs, which is the controlling principle in any business. It is easy to ascertain the market values of crude materials and finished products, but the long array of numerical details intervening which constitute the business of manufacture is a closed volume to every one outside the counting room. The guiding thought of the student is the acquisition of accurate knowledge of principles and methods. The chief aim of the manufacturer is to apply those methods in such a manner that the pecuniary results may be entered on the right side of the balance sheet in the shortest possible time. As an example of this difference in motive it is often suggested that students in quantitative analysis be given practise in rapid application of methods; but the fact is forgotten that the student is fully occupied in the attainment of accuracy, and that rapidity is soon acquired. It may take him a day or two to master the necessary dexterity in applying the method for the determination of phosphorus in a single sample of steel. When he goes out into the factory laboratory he may be required to hand in results on thirty samples in a single day. This distinction seems to be best expressed by the difference in environment; the student acquires his knowledge in the quiet atmosphere of the educational institution; the man of business applies his knowledge under the stress of manufacturing conditions.

The service of the school of science for the benefit of the community is well established, but it has not yet secured the tenacious hold of the older college, which, in educating generation after generation, father and son, has established the traditions of the family on scholarship and culture, and extended the influence of collegiate training into the professional and business world. The first generation of graduates from the scientific school has had barely time to make its record, but an honorable record is assured, and it will be continued by their sons and grandsons. Traditional family support of an institution is one of its most valuable assets intellectually and pecuniarily; fortunate is the institution that has this support in the best families.

The school of science in its breadth of training and scope of applications is peculiarly an American institution. In England, until recently, the spirit of progress along similar lines has been somewhat inactive. But aroused by the recent great industrial activity to the fact that their old-time plants must be rehabilitated and that our young men are being called on for assistance, large grants have been made to establish schools of science, and the managers of these funds are inquiring with much interest into the foundation and operation of our scientific institutions. The fact is being recognized that the business world is receiving aid from practical methods that they must adopt to regain their industrial standing.

In Germany the conditions are essentially different. While the labors of the early French and English investigators contributed very largely to the foundation of chemical science, our immediate inspiration came from the German laboratory. More recently the unprecedented expansion of our national resources has developed circumstances so fundamentally different, our institutions have of necessity directed their efforts toward meeting business requirements to the extent that they are unique. Yet the atmosphere of quiet scholarly inquiry of the German institutions still retains its influence. The great body of German scholars in happiness and contentment devote their lives to discovery and elaboration with sufficient remuneration for economical living and simple habits, and the world is benefited by their labors. In the great manufactory such as that of the Badische Aniline Fabrique or of Meister, Lucius and Bruening hundreds of chemists are employed, a large proportion with doctorate degrees from the universities. Those men are devoting their best efforts to the interests of their employers in the national spirit of faithful application and with very moderate compensation. If such establishments were compelled to pay salaries equivalent to those granted for similar service in our own factories, it would doubtless make a serious inroad in the very generous dividends they are now able to declare.

It is extremely doubtful whether the conditions in the German university, including their long vacations, their leisurely habits during the semesters, and with no restraint on the student except attendance at final examinations, are applicable in American schools of science. Certainly their traditional method of allowing the student, whatever his capacity, to work out problems on his own resources, even before he is well grounded in breadth of practical methods, could not meet our requirements.

I am sure there will be no dissent from the view that original research is of equal importance in the school of science as in the university, although evidently it should take a somewhat different form in the scientific institution. In the university labo-

ratory, research has for its object the advancement of knowledge with no visible practical utilization. The same spirit must pervade all research; that is, its foundation rests on the principles of pure science. In the scientific school the great field includes the application of the principles of pure science to the solution of commercial problems. To one who is conversant with the conditions in the manufacturing plant that lacks the aid of men skilled in science it is evident that much of the work is the result of disconnected observations loosely made in a rule-of-thumb fashion, rather than the outcome of systematic study of underlying principles with expansion to methodical application. There is urgent need of the extension in all directions of the critical comparison of methods of analysis and testing which has made such a good beginning. To appreciate the importance of this work it is only necessary to glance at the want of concordance in the results of analysis of a given substance even from the best laboratories. The recent establishment of the national bureau of standards is an excellent foundation for greater accuracy and closer agreement in the results of different workers.

The education of the professional chemist is concerned in the recent discussion on the relations of the scientific school to the university, and the cogent reasons suggested for its rehabiliment as one of the professional departments with law, medicine, etc. If such a change were feasible doubtless scientific education should proceed along much the same lines, for the seeker after its benefits could not otherwise secure his training, and the instruction would of necessity conform to the demands of business. The endowment of other schools of science is not probable; the present tendency is rather to expand scientific training in institutions already established. This is especially true of the state universities, in some of which the best practical training in science is given. The permanency of those institutions in their reliance on the state gives promise of the broad development of practical science. What may be said in this direction relates, therefore, to a comparatively few institutions, and it evidently applies to a few conditions concerning which there are doubtless differences of opinion—culture, educational atmosphere, policy of management, economy in resources. That the student of applied science should gain in culture and breadth of thought in the university atmosphere may be true with corresponding changes in his work; but the strictly professional training can not be abbreviated, and it is believed that culture should be imparted in these courses as now conducted in the scientific institution. As to whether the university atmosphere is well adapted to the close application and vigorous effort required in the school of science, may be questioned. Besides certain small economy in office supervision, it does not appear that any important reduction in running expense is possible. There is a limit to the number of students in a single recitation or laboratory division. A given number of students in the scientific school needs the same number of teachers and the same equipment as in the university.

In respect to policy and administration it would seem that the school of science has an essential advantage over the professional department in the university. The head of the scientific school devotes his best thought and energy with an intense personal interest to his institution. Such devoted service from a president thoroughly imbued with the scientific spirit, with such expert knowledge and force of character that his word has carrying power with the public and with governing boards as well as with-

in the institution, and with business instincts that enable him to meet men of affairs on grounds of mutual interest and understanding, must of necessity be more efficient than that of the dean who is interested in his department as one element of a great university, not wholly independent in applying his convictions nor untrammeled by other considerations incident to his department. It is no doubt true that the conditions affecting the school of science in its relations to the business world are essentially different from those of law and medicine, as integral elements of the university.

With reference to a combination in resources which is the chief source of strength in the great modern business corporation and its application along similar lines in the university, the successful element in the manufacturing corporation is the elimination of manual labor with its uncertainties and imperfections, and its more general displacement by machinery that is invariable in its operation. It is admitted that without the larger substitution of labor by machinery, the same efficiency and economy are not secured in manufacturing plants in which details are altogether in the hands of salaried employees, as was possible in the earlier period when smaller branches of business were under the direct personal supervision of the owners. On the other hand, in the educational field, mind is the immediate controlling and directing power in every detail, with no intervention of mechanical appliances. The teacher can not direct his students and carry on his instruction from a distant city, or from another continent.

The essential principle of combination in business, that modern conditions demand great accumulations of capital and resources for control in competition and commerical fluctuations, does not apply in a similar degree to any successful educational institution, for there is a far greater demand for graduates than can be supplied, and there is little difficulty in securing necessary funds for carrying on fundamental lines of educational work. If it be true, as has been stated, that the German universities are much overcrowded with respect to employment after graduation, and that strenuous efforts are put forth through German residents in this country to place their graduates here, the element of competition is not wanting, or may not be in the immediate future. Such competition may even be a stimulating advantage, inciting the workers here to greater effort. Already we have cause for congratulation in the standing of our research laboratories, especially in physical chemistry. It is an indication of a leading position in research and the advancement of knowledge to which the devoted labors of the numerous able investigators in this country during the last thirty years have contributed. A powerful aid, which it is all too soon to appreciate in its desirable results, is the immense funds for research recently established. Although primarily these grants are made in furtherance of work in pure science, evidently applied science and professional chemists will be greatly benefited. Perhaps the wisest grant of all is the Carnegie foundation for the retirement of teachers, for in a measure it relieves the teacher during his earlier years from the anxiety of later need, and gives him courage to devote his residual energy in some efforts for the advancement of knowledge. Every institution named in this grant is benefited in its standing, for it may insist that applicants for positions have adequate training for research, and that their ambition lie in that direction.

In the changes in business management during the last decade, and the transfer of business control from private ownership to

great corporate bodies in which the vested property rights have passed into possession of the general public by the distribution of shares and bonds, there is an indication of a tendency toward the creation of a class distinction in labor as well as in property control. It is not at present so apparent in its results as it will doubtless appear later when the very prosperous conditions of business and consequent increase in private fortunes and lavish expenditure shall inevitably be affected by enforced economy of a more stringent commercial situation. At present all forms of labor are employed with increased compensation and with a serious deficiency in many directions. But there is an evident tendency toward a lower valuation of mere manual force and an increased valuation of mental agency. In corporate control success depends, in some directions altogether, on the personal qualifications of a superintendent or manager, and the right sort of men are much sought for and difficult to secure. The pressing need is for managers of executive capability for manipulating men and methods, and it has developed so suddenly, it is all too soon for the production of an adequate supply. A great business corporation can be created in a day; but years are necessary to produce men who can manage its departments.

Class distinction in labor will appear in the elevation of skilled labor, the thoroughly trained man of science of executive ability, and the manager, and the degradation of brute force as it is embodied in the individual whose possession consists only in what nature has conferred on him. What will become of the latter as the labor of his hands is more and more completely replaced by machinery that can do his work better, is one of the great problems of the future. It will be a question of the survival of the fittest, and one that has a lively interest for the youth who is now deciding what his future shall be, for this, and other similar phases of social and industrial life, will be brought prominently into view during his generation.

A feature of modern progress that has an intense personal interest to every individual in active business life is the tenure of activity. Formerly the connection with affairs of business was coincident with life itself. But the old-time methodical, slow-moving habits of the last generation of business men whose attendance in the counting-room included the daily working hours, has given place to close connections by telegraph, telephone, limited trains and other inventions that tax human endurance. The father attended to his correspondence, writing all his letters; the son takes up a pen only to sign checks and documents. The youth of the present day must amass his fortune, make his reputation, get his enjoyment and pleasure in business affairs and be ready to resign his place to another at the age of fifty or sixty years, at just the period of life when the normal man should be in his prime, and able to render his best service by reason of his experience and mature judgment. This is a serious limitation for young men who have spent eight years or more of their lives in gaining an education, although the graduate of the school of science has an advantage over those who select other professions that require three years or more of additional preparation, which with subsequent office practise render it scarcely possible for the young lawyer or doctor to start out in business for himself much before the age of thirty years. In taking a position immediately after graduation in the manufactory, the man of science is making his way while he is gaining his business experience. Ten or fifteen years at least are necessary to develop the productive capacity of any man; and the remaining few years permitted to

him for accumulation demand the utmost concentration of effort. What will be the result of this intense strain, and the effects of such a time limit on what the average man hopes to accomplish, can only be ascertained by future observation. But the situation is inevitable, and the young man is wise who heeds for his future the counsel and experience of his elders.

It would seem that these various influences have an important bearing on the present and future conditions of practical education in determining what the student may expect who seeks a suitable preparation for the profession that will absorb his best energies and that shall constitute his life-work. It is of less consequence where he is educated, provided he attains the mental poise and attitude that enable him to grasp fundamental truths and to apply them correctly in the accomplishment of great undertakings.

C. F. MABERY
CASE SCHOOL OF APPLIED SCIENCE

SECTION K—PHYSIOLOGY AND EXPERIMENTAL MEDICINE

SUMMARY OF THE PROCEEDINGS

THERE were three meetings of the section during convocation week.

The first session was convened on Thursday, December 27, at 2:15 P.M., at the College of Physicians and Surgeons, in the presence of an unusually large audience. At this meeting the officers for the year 1907–8 were elected; the retiring chairman, Professor William T. Sedgwick, delivered the annual address; and a symposium was held on the subject of 'Protozoa as Factors in Disease.'

The second session was held on Friday, December 28, at 10 A.M., at the Rockefeller Institute for Medical Research, in affiliation with the Society of American Bacteriologists. Twelve papers were presented.

The third session was held on Saturday, December 29, at 10 A.M., at the Rockefeller Institute for Medical Research, in affiliation with the American Physiological Society. Sixteen communications were offered.

EXECUTIVE PROCEEDINGS

The following officers were elected for 1907–8:

Vice-president and chairman of the Section—Ludvig Hektoen.

Secretary—William J. Gies.

Sectional committee—Simon Flexner, vice-president, 1906–'07; Ludvig Hektoen, vice-president, 1907–'08; William J. Gies, secretary, 1905–'08; Charles S. Minot (one year); J. McK. Cattell (two years); Frederick G. Novy (three years); Graham Lusk (four years); Jacques Loeb (five years).

Member of the Council—S. J. Meltzer.

Member of the General Committee—Edward K. Dunham.

SCIENTIFIC PROCEEDINGS

Program of the First Session, December 27, 1906

Vice-presidential address—'The Expansion of Physiology': William T. Sedgwick. (Published in SCIENCE, this volume, page 332.)

Symposium on Protozoa as Factors in Disease:

Introductory remarks by the chairman: Simon Flexner.

'The Protozoa from the Standpoint of the General Naturalist': Edmund B. Wilson.

'Some General Principles in connection with Protozoa as Factors in Disease': C. W. Stiles.

'The Protozoan Species': Gary N. Calkins.

'The Morphological Diagnosis of Pathogenic Protozoa': James Ewing.

'Immunity against Trypanosomes': F. G. Novy.

General discussion by William H. Welch, Henry B. Ward and James Carroll.

The Protozoa from the Standpoint of the General Naturalist: EDMUND B. WILSON.

The zoologist who is asked to open a discussion on pathogenic protozoa with a few remarks on these animals as they appear from the standpoint of the general naturalist must approach his task with somewhat mixed feelings. There is hardly a field in zoology more interesting or fuller of suggestion; but neither has any other been oftener traversed or more widely exploited. Indeed the subject has been so often discussed, its importance is so well understood, that I am tempted to begin and end with the celebrated remark of Colonel Ingham's double that "there has been so much said, and on the whole so well said, that I will not further occupy the time." And yet there are certain aspects of the subject to which one may again and again return without loss of interest, which are a perennial spring of new ideas and new research. First and foremost among these is the fundamental analogy pointed out by Virchow and Haeckel between the animal body and an organized social state. The conception that the multicellular body is a 'cell-state'—a community of cooperating elementary organisms that are individually comparable to protozoa—made a deep and lasting mark on all morphology, physiology and pathology. Apparently there is no end to the fruits that it has produced, continues to yield, and seems likely to bring forth hereafter. The conception is no doubt an inadequate one. There are some, perhaps many, biological processes that can not adequately or profitably be considered from this point of view alone. Especially in the field of growth and development there are processes that are better treated as the action of a single and indivisible physiological unit than as a resultant of cooperating cell-activities. But, whatever its limitation may be, the conception of the 'cell state' remains one of the most brilliant, interesting and fruitful of the fundamental generalizations of biology. It is part of the air we breathe in every biological laboratory from the day we first sit down to the microscope, and in one way or other it pervades the whole tissue of our work. As such it needs no analysis at my hands.

But there are certain applications of this conception to some of the broader questions of our science on which for a moment I may appropriately dwell. For instance, our conception of heredity, on which the whole modern theory of evolution turns, has been profoundly affected by the phenomena of reproduction in the protozoa; and the same is true of the whole constellation of problems relating to sexuality, the duration of life, old age, and the renewal of vitality by fertilization, all of which are in close relation to the problems of heredity. A great number of the modern researches on these questions can be recognized as fruits of the celebrated comparison, drawn by Bütschli thirty years ago, between the life-cycle of a protozoan race and that of a multicellular animal. Fertilization of the egg is analogous to the conjugation of the protozoa; cleavage and development to the successive divisions of the ex-conjugants and their descendants; maturity, decline and old age in the multicellular organism to the physiological balance and the ensuing gradual failure of vitality after prolonged vegetative reproduction in the protozoa; the stimulus to development given by fertilization is comparable to the renewal of vitality that follows conjugation in the protozoa. This comparison has directly or indirectly stimulated a multitude of important and interesting researches on the fertilization of the egg, on artificial parthenogenesis, on the chemical renewal of vitality in the protozoa, on the stages of

growth and decline, on the causes of old age and natural death, and many others. There is not one of these questions that can be adequately considered apart from the phenomena exhibited by the protozoa. It is my impression that we are more likely to solve these problems, in so far as they can be solved, by studies on the protozoa than by investigation on the higher forms. Some of the researches in this field have definitely brought into the arena of scientific experiment and discussion the old dream of the alchemists of the artificial prolongation of life, perhaps of human life. If this is no longer a fantastic vision of pseudo-science but has won a place among the legitimate subjects of scientific inquiry, it is in no small measure owing to investigations on the protozoa.

If we turn for a moment to the study of heredity and evolution, here again it was in considerable measure a comparison of the life histories of protozoa with those of metazoa that necessitated a readjustment of many views that had long been held, almost without question, as applicable to the higher forms of life. Considerations on reproduction and the duration of life in protozoa formed the starting point of Weismann's inquiries on heredity that resulted in a total denial by him of the inheritance of acquired characters in higher organisms —a supposed factor that formed an important part of Darwin's general theory and was the very corner-stone of Herbert Spencer's philosophy of organic nature. Whether Weismann was right remains to be seen. Naturalists are still in disagreement as to whether acquired characters are inherited or not. But there can be no doubt that Nussbaum and Weismann altered our whole point of view by fixing attention on the fact that heredity is effected in metazoa, as in protozoa, by cell-division; that just as protozoa inherit the characteristics of the mother cell because directly derived from it by division, so the body of the higher animal inherits not from the body of the parent but from the egg, because derived from it by division. This simple fact, while it places the basis of heredity in its true light, enormously increases the difficulty of accepting the inheritance of acquired characteristics of the body. That such an inheritance of acquired characters is difficult to conceive does not, of course, prove that it is not a fact; but the arguments urged by Weismann were of such force as to demonstrate the imperative need of a reexamination of the whole question. The illuminating view of heredity brought forward by Nussbaum and Weismann, primarily suggested, I repeat, by the mode of reproduction in protozoa, has made a deep mark on biological research, and has led to reinvestigation of many conclusions that had naïvely been taken for granted, with no realizing sense of the formidable difficulties that they involved, or the weakness of the evidence on which they had been based. Thus the study of the protozoa has had its effect on every part of biology that is concerned with questions of historical descent; and I do not think it forced to say that these creatures may have something to teach us in every department of thought into which evolutionary considerations enter.

It was Weismann's view that the protozoa are endowed with never-ending life. From the physical point of view, this conclusion was not altogether well founded, at least in the sense in which he meant it; but metaphorically speaking it was true. They certainly possess a vitality that seems without limit as a power to animate scientific research, to invade new fields of discovery. Their latest achievement is an irruption into the domain of pathology, and the inroads they have already made are

sufficiently attested by the choice of the subject of this discussion. I feel myself here on treacherous ground and will venture no prediction as to whither the new subject of medical protozoology may lead us. But evidently the bacteria must look to their laurels with so formidable a competitor in the field. It is within the bounds of possibility that the discovery of the causal relation between protozoa and disease may one day rank with the greatest of those that general biology owes to the study of these simple animals.

Some General Principles in connection with Protozoa as Factors in Disease: C. W. Stiles.

The speaker first directed attention to the difficulties of classification and the necessity for extensive academic work on protozoology independent of the subject of applied protozoology. Because of incomplete knowledge of the protozoa, we must expect to meet with extensive differences of opinion in reference to numerous species or alleged species, for some years to come. These differences in interpretation are at present inevitable and should be accepted as having a right to existence; they do not necessarily indicate any special prejudice or unreasonableness on the part of contending authors. Zoologists are at present not in a position to concisely define the protozoa as a systematic unit, nor can they yet define sharply the different groups from one another. We must, therefore, have patience at present and receive with open minds, although with some reserve, many interpretations that are published. He referred to the two biologic rules he had enunciated in 1901, to the effect that diseases which are conveyed mechanically by arthropods (as facultative carriers) may be due to either plant or to animal parasites, but chiefly to the former, while diseases which are conveyed biologically by arthropods (as obligatory carriers) are, so far as known, due to animal parasites. In discussing the relation of Rocky Mountain fever, African tick fever and chicken spirillosis, to these same rules, he held that we must await further study in the case of Rocky Mountain spotted fever, while in the case of tick fever and chicken spirillosis it has not yet been proved that the ticks are biological (obligatory) carriers. In chicken spirillosis the disease has, according to literature, been conveyed through feeding the feces of a sick animal to a well animal, hence in nature, this disease does not seem biologically dependent on the ticks. As for African fever, there are certain indications, though as yet no proof, that this can be conveyed as a wound disease.

Passing to yellow fever, the speaker thought that despite certain opinions to the contrary, the present indications remain in favor of a protozoal rather than a protophytic origin.

The Protozoan Species: Gary N. Calkins.

Formerly it was the custom to base protozoan species on the structure of the single cell. This made it very easy to make new species, for any novice with a microscope might see known organisms new to him and describe them as new species thus burdening the literature with names and pseudonyms. On this former basis there were so few points of structure to base species upon that they were difficult to accurately define.

A species in zoology is an abstract conception of a group of animals based upon similarity in structure, habits and mode of life and power of reproducing amongst themselves offspring identical with themselves.

In the single individual of a species we usually recognize more or less clearly defined variations in vitality and sequence of changes which we designate as youth, adol-

escence and old age, the whole constituting a life history.

In the protozoan species, according to the old custom in taxonomy, these criteria of species can not be maintained. The individual, in the first place, has no life history to speak of; it is formed by division of a cell; it lives only a few hours as an independent cell and then disappears, its substance going into two or many new cells. There is no indication of the changes in vitality characteristic of individuals of metazoa, that is, no trace of periods of youth, adolescence and old age while natural death of the individual is unknown. Furthermore, in such individuals the criterion of offspring which exactly resemble the parents is not observed, for cells may be formed in the course of the several divisions which do not at all resemble the parent cell and which seen independently would warrant interpretation as a new species. Thus in *Tetramitus* or *Cercomonas* the perfectly rigid contour of the ordinary 'individual' is very different from the amœboid 'individual' which is ultimately formed. On the basis of such variable 'individuals' the protozoan species must be of questionable taxonomic value.

A new basis for the conception of protozoan species was given by Schaudinn in 1900. Always interested more particularly in the life history of protozoa, he gave from time to time more or less complete accounts of the life cycle of different forms, *e. g., Calcituba, Leydenia, Polystomella, Paramœba, Trichosphærium,* etc., while in this year he founded *Coccidium schubergi* on the basis of the complete life cycle and gave us a model which later students of the group have tried to follow.

The new method of taxonomic research which Schaudinn started has resulted in a far more profound knowledge of protozoan species. A number of supposedly different varieties, species and even genera have been found to be only stages in some life cycle. For example, microsphæric and macrosphæric shells of foraminifera are now known to be only stages in the life history of the individual foraminiferon, and in my own experience some of the commonest forms of microscopic life are found to be curiously related. Thus an organism which formerly any student of the protozoa would have described as a species of the genus *Pelomyxa,* is found to be only a stage in the life history of *Amœba;* and the supposedly different species of *Paramecium—caudatum* and *aurelia*—are found by continuous culture in their natural habitat to be one and the same species.

Other examples might be given to show how the 'individual' in the old sense varies from time to time and thus becomes a most unstable subject of protozoan species. For this reason, I have urged that the old idea of the protozoan 'individual' be discarded and the life cycle substituted, and I would recognize as the individual, not the single cell but the entire aggregate of cells that are formed from the time of one conjugation up to natural death of the protoplasm resulting from it, or until syngamous union of that protoplasm with similar substance from another individual.

In such an individual we recognize periods of varying vitality which have the same sequence as in metazoa, and we can find characteristic features which indicate the period of youth, of adolescence or old age as in a metazoon. The variations in vitality may be represented by a more or less regular curve in which these periods are clearly marked out.

It is particularly important that species limits should be clearly defined among the pathogenic protozoa. Here as yet, however, there are very few that are based upon the full life cycle, most of them indeed are on

the basis of a few individual cells. For example, Woodcock in his review of the hæmoflagellates enumerates no less than forty-eight species of *Trypanosoma* and adds two additional ones as questionable. I do not wish to be too severe, but I imagine it would be nearer the truth had the account been of two species and forty-eight questionable ones. In this group species are based for the most part on unmeasurable differences in structure; often indeed no such differences even can be made out—but species are defined on strictly physiological characters, such as life in different hosts, inability to live on certain culture media, different reactions towards immune sera, etc., none of which are sufficiently characteristic of species, although they may well indicate specific differences.

In very few cases has the life history of the trypanosome been made out, but the work of Schaudinn, Keysselitz and Prowazek indicates that we have to do with digenetic forms, while Novy's conclusions are the reverse. It seems to me that the culture method can not be relied on absolutely in the testing of protozoan species; to cultivate parasitic protozoa on media is to cultivate them in one phase only of their life history, and since the most important phases have never been seen in the cultivated forms it is probable that the period of youth of the individuals is the best for cultivation. Inability to live in the same medium is no test of a good species. There are many species of protozoa which live both in salt and in fresh water; either if transferred suddenly to the other medium would die, but either could be gradually trained to live in the other medium. So it is, as I believe, with *Trypanosoma,* and the multiplication of species here is, to my mind, only evidence of our ignorance of their life history.

What is true of *Trypanosoma* is even more evident in the case of *Spirochæta.* Here, every month or so, some student of the group describes a new species of *Spirochæta* before we have found out even whether the genus to which it is ascribed belongs to the Schizomycetes or to the Mastigophora. Again the variations in structure of the various spirochætes are so great that if they were all true we should have to make new generic names to hold them. *S. obermeieri,* for example, has the chromatoid granules of a bacillus, it reproduces by transverse division, and is, in its morphological characters much more like the spirilla type than like the flagellate forms. *S. plicatilis,* on the other hand, has longitudinal division, a periplast membrane and nucleus similar to that of the male trypanosome, according to Prowazek. *S. pallida,* finally, has flagella, and reproduces by longitudinal division according to Schaudinn, and has a single nucleus according to Schaudinn, Herzheimer, Krzyztalowicz, Siedlecki and Forrest, and trypanosome phases according to Siedlecki.

Out of this heterogeneous collection it would seem to me that *S. obermeieri* might well be a spirillum while the rest that I have mentioned may be *Spirochæta.* Whatever they are, it is quite evident that we are here in territory which lies between the two divisions of schizomycetes and mastigophora and to tell whether a given *Spirochæta* is a plant or an animal is only an academic matter after all. What we really want to know is the life history of the individual and the form changes through which it passes. When these are ascertained the genera, families, orders and classes, or kingdoms, will take care of themselves.

The Morphological Diagnosis of Pathogenic Protozoa: James Ewing.

A review of protozoan morphology shows that all these organisms at some stages of development assume very characteristic

forms which leave no doubt that they belong to a living structure. This is especially true of the recognized pathogenic protozoa of man and the higher animals. Hence some zoologists have taken the ground that when a protozoon is encountered under the microscope its characteristic forms can be recognized at a glance. Nevertheless, there has been a constant endeavor to force the acceptance, as protozoa, of various specific intracellular bodies found in cancer, rabies, the exanthemata, and certain related diseases of lower animals, although the structure of these bodies is not clearly protozoan. The danger of accepting these doubtful bodies as protozoa lies in the fact that not only in these diseases, but in others of known bacterial origin (diphtheria, glanders), there are peculiar intracellular degenerative products, more or less specific of each disease and organ, all of which closely resemble some forms of protozoa. Hence in the absence of entirely characteristic trophozoites, sporocysts, or spores, it is unsafe to regard any of the bodies as protozoa. The morphological study of the cell inclusions in cancer, variola, scarlatina, measles, rabies, clavellé, contagious epithelioma of birds, etc., has not led to a definite result in any of them.

In the absence of fully characteristic protozoan forms, the circumstantial or collateral evidence becomes of decisive importance. This collateral evidence in cancer is practically conclusive against the protozoan nature of the disease, and of the various cancer parasites. In the exanthemata it does not seem favorable to the protozoan nature of the bodies described as parasites, nor to the protozoan theory of the origin of these diseases. In rabies there are somewhat more definite indications pointing to the protozoan nature of the disease and of the Negri bodies, but this evidence is still inconclusive. The study of diseases of unknown etiology exclusively from the protozoon standpoint is to be deprecated. There are some grounds for supposing that the above diseases, except cancer, may be due to invisible but not necessarily sub-microscopic organisms or even to peculiar actions of well-known bacteria. The virus in the exanthemata, and probably in rabies, is perhaps connected with the specific cellular products of these diseases, but is itself of a nature not understood, and yet unparalleled among known protozoa.

Immunity against Trypanosomes: F. G. NOVY.

It is an established fact that rats which have recovered from an infection with *T. Lewisi* are immune to subsequent inoculation with that species of flagellate. The same holds true for cattle, sheep, goats, etc., that have recovered from the infection caused by the pathogenic trypanosomes, such as nagana, surra, dourine, etc. This condition of active immunity is seemingly possible only in those species of animals that are relatively insusceptible, for with really susceptible species the infection is always fatal.

Heretofore all experiments on artificial immunity against trypanosomes have been made on animals that have recovered from the effects of the parasite which has been living and multiplying in the blood-vessels of that animal. Now that cultures of some of these organisms, as for example *T. lewisi* of the rat and *T. brucei* of nagana, are possible it was desirable to ascertain whether or not they could be used to immunize against the virulent organisms. It may be said, in passing, that cultures of both of these trypanosomes, even after they have passed through a hundred generations or subcultures in the course of two years, do not become attenuated by such pro-

longed consecutive passage but readily infect susceptible animals.

We have shown, however, that cultures of *T. brucei* can be attenuated by exposure for about two days at 34° C. By repeated injections of cultures thus treated, attempts have been made to immunize rats and guinea pigs against *T. brucei,* but thus far these have been but partially successful. That is to say, there has been at most a survival of a few days of the treated as compared with the untreated animals. The failure to immunize with such cultures is attributable in part to the excessive susceptibility, of the animals employed, to infection with *T. brucei,* and in part to the existence of a negative phase following the injections. It is desirable to repeat these experiments with less susceptible animals.

In view of the fact that rats invariably recover, some soon, others late, from infection with *T. lewisi* and the further fact that rich cultures of this organism are readily obtainable, it is evident that this species is well adapted for studies on immunity. Up to the present time it has not been satisfactorily shown that trypanosomes elaborate toxins or that they confer immunity by means of soluble or intracellular products. The latter problem was approached by means of plasmolyzed cultures. To effect solution of the trypanosomal cells the cultures were taken up in distilled water and dialyzed in collodium sacs. Usually after one or two hours of such dialysis in distilled water the trypanosomes completely disappear and the intracellular matter apparently passes into solution.

By means of such plasmolyzed cultures it has been shown that rats which receive three or more injections, on alternate days, on subsequent inoculation with a minimal infective dose of fresh trypanosomal blood from a rat do not become infected, whereas controls are positive. With such solutions it is possible to hyperimmunize rats so that 0.5 c.c. of the immune rat blood protects against a simultaneous and separate injection of the infective blood.

Protection is seemingly obtained against *T. lewisi* by simultaneous and separate injection of the infective blood and plasmolyzed culture, followed twenty-four hours later by a second injection of the latter. Repeated injections of too large a quantity of the plasmolyzed culture and at too short an interval leads to a negative phase, the presence of which is indicated by the unusually early appearance of trypanosomes in the blood after inoculation with the virus.

Inasmuch as it may be said that the plasmolyzed material does not represent a true solution, a series of experiments were made with the filtered (Berkefeld) plasmolyzed liquid. While these experiments go to show that immunity can probably be induced by such filtered soluble products they are not as decisive as they should be and for that reason will have to be repeated. The chief reason for this uncertain result is the rather frequent failure of the control rats to develop infection. Although young rats (50–80 grams) were used to guard against previous infection with trypanosomes it is certain that a large percentage of the rats, as purchased on the market, have acquired an immunity against *T. lewisi.* That the immunity encountered is really acquired and not natural is shown by the fact that we have many times isolated *T. lewisi,* by means of the cultivation method, from rats which on repeated examination were found to be free from parasites and hence were supposed to be normal.

Program of the Second Session, December 28, 1906

(Joint meeting of Section K and the Society of American Bacteriologists.)

On the Biology of Diplococcus intracellularis: SIMON FLEXNER.

The Stability of Tetanus Toxin: M. J. ROSENAU.

Some Observations on the Blood of Horses: J. J. KINYOUN.

The Alleged Rôle of Intestinal Worms as Inoculating Agents in Typhoid Fever: C. W. STILES.

The Absorption of the Third Serum Component: W. H. MANWARING.

The So-called Physical Chemistry of Hemolytic Serum: W. H. MANWARING.

On the Chemical Inactivation and Regeneration of Complement: HIDEYO NOGUCHI.

On the Electric Charge carried by Toxins, Antitoxins and Agglutinins: C. W. FIELD.

An Improved Technic for Tuberculo-opsonic Preparations: A. P. OHLMACHER.

Some Suggestions concerning the Terminology of Opsonic Theory and Practise: A. P. OHLMACHER.

The Generic Characters of the Coccaceæ: C. E. A. WINSLOW and Miss A. F. ROGERS.

Actinomyces of the Oral Cavity: D. H. BERGEY.

Program of the Third Session, December 29, 1906

(Joint meeting of Section K and the American Physiological Society.)

The Functions of the Ear of the Dancing Mouse: R. M. YERKES.

The Effect of Section of One Vagus upon the Secondary Peristalsis of the Esophagus: S. J. MELTZER and JOHN AUER.

On the Alleged Adaptation of the Salivary Glands to Diet: F. P. UNDERHILL and L. B. MENDEL.

Adaptation of Saliva to Diet: C. H. NEILSON.

The Effect of Phosphorus Starvation on Aspergillus niger: WALDEMAR KOCH and H. S. REED.

New Chemical Facts about Tendon and Compound Proteins: WILLIAM J. GIES.

A Further Study of Peptolysis: W. N. BERG and WILLIAM J. GIES.

The Action of Blood Serum and Tissue Extracts on the Coagulation of the Blood: LEO LOEB.

Some Observations on the Esophagus after Bilateral Vagotomy: W. B. CANNON.

Concerning the Pharmacological Action of Salicylic Acid: L. B. STOOKEY and M. MORRIS.

A Nuclein Metabolism Experiment on a Dog with an Eck Fistula: P. A. LEVENE and J. E. SWEET.

Protein Analysis: P. A. LEVENE, W. A. BEATTY, D. R. MACLAURIN and C. H. RUILLER.

A Demonstration of Normal Gastric Peristalsis in the Rabbit: JOHN AUER.

Peristalsis of the Rabbit's Cecum (with demonstration): JOHN AUER and S. J. MELTZER.

Preservation of Blood Vessels in Cold Storage: ALEXIS CARREL.

Demonstration of Failure of Regeneration of the Cervical Ganglion Twenty-six Months after its Removal: S. J. MELTZER.

WILLIAM J. GIES,
Secretary

SCIENTIFIC BOOKS

THE TERRACES OF THE MARYLAND COASTAL PLAIN

Maryland Geological Survey. Pleiocene and Pleistocene. Baltimore, 1906. Pp. 291, plates and maps.

The high standard of investigation and publication reached in the previous reports of the Maryland Geological Survey under the direction of Professor W. B. Clark is maintained in the recent volume on the 'Pleiocene and Pleistocene of the Coastal Plain'; the later physical history of the district being treated by G. B. Shattuck, recently of Johns Hopkins University, now professor of geology at Vassar College, while its paleontology is discussed by Clark, Lucas, Hollick and other experts. The chief physical results of this elaborate study, already outlined by Shattuck six years ago ('The Pleistocene Problem of the North Atlantic Coastal Plain,' Johns Hopkins University Circulars, No. 152, 1901), concern the marine terraces that have been carved on the slopes of the previously dissected coastal plain, and are presented in the first half of the report under such headings as general stratigraphic relations, physiography of each terrace, structure of each terrace, method of interpretation, resulting inferences as to geological history, and summary. The chapters on paleontology include a general account of the Pleistocene fauna by Clark, and flora by Hollick; then a discussion of systematic paleontology under ten headings from mammalia to spermatophyta by various authors, and a special chapter on the elephants of the Pleistocene by Lucas. So detailed a treatment of Pleistocene paleontology is novel in American geological reports.

The geological history of the region to which this review is directed, may be briefly summarized as follows: The series of marine strata, chiefly Cretaceous and Tertiary, which make up the body of the Maryland portion of the Atlantic coastal plain, was uplifted and perhaps nearly baseleveled by subaerial erosion, in time to receive, when again submerged, a broad sheet of Lafayette (Pleiocene) gravels and sands. Another uplift again exposed the coastal plain, thus renovated, to prolonged erosion under the leadership of the Potomac, Susquehanna (Chesapeake), and other large rivers, the main valleys thus gaining an expression of advanced maturity, with depth and breadth perhaps not far short of the dimensions which they now possess. Next came a strong depression; the mature valleys were drowned and a well-defined shore-cliff or scarp was cut on their slopes (the stage of development reached by the shore line being inferred by the reviewer to have been advanced youth or early maturity). Sunderland is the name given to this scarp and to the associated marine terrace deposits then formed. A series of short-lived partial uplifts and slight depressions followed; each uplift permitting a renewal of dissection on the emerged slopes; each depression sufficing to produce a new scarp with a submarine terrace. Three sets of scarps and terraces below the Sunderland were thus formed; the Wicómico, the Talbot and the Recent; all, like the Sunderland, contouring around the frayed-out slopes of the dissected coastal plain, and now standing at altitudes of (about) 200, 100, 40 and zero feet.

This interpretation has two chief bases. First, a critical study of the features along the present shore line; second, a comparison of these features with similar features at higher levels. The work has every appearance of being carefully done. It will be interesting to note how far the conclusions are supported by new studies, either of a more detailed character in Maryland, or of a broader character in neighboring states.

An understanding of the development of the present shore line is evidently of fundamental importance. It is shown to have followed a moderate submergence of the previously dissected coastal plain. The very irregular initial shore line thus produced has been systematically modified by the development of long, off-shore sand reefs on the most exposed ocean front, while scarps have been cut on the headlands of the less exposed bays, and short sand reefs have frequently been thrown across the smaller reentrants within which deltas and marshes have accumulated. At the same time a submarine terrace of gravels, sands and clays is believed to have been formed for a certain distance off shore. At various points where the headland scarps are cut back, the neighboring sand reefs have been forced to retreat at about the same rate; and thus the inner border of the stratified terrace

deposits, containing marine fossils, is believed to be locally superposed upon the fresh-water or brackish-water sands and clays of the delta and marsh reentrants. The base-line of the scarps, the surface of the delta plains, and the inner border of the marine terrace are all closely at the same level. The scarps rise sharply above their base line, and gain a height dependent on the altitude of the headland in which they were cut; the terraces slope very gently waterward, their layers resting unconformably on the submerged and eroded land-surface, and their composition and thickness presumably varying with local changes of depth, waves and currents.

It is the occurrence, at various altitudes above sea-level, of features similar to those of the present shore line, but now more or less wasted by erosion, that has led Shattuck to his ingenious interpretation of the Sunderland, Wicómico and Talbot terraces. He traversed the coastal plain in all directions, but not until it occurred to him to explain its details of form and structure by means of marine action at several levels was it possible to bring order out of confusion. The scarps, especially the higher earlier ones, are dulled by weathering; and the terrace fronts are dissected by retrogressive streams, especially where undercut by the next lower scarp. Nevertheless they are still traceable. It is significant that the correlation of the different parts of each terrace is usually not based on paleontological evidence, for most of the deposits do not bear fossils; nor on diversity of composition, for the materials of the successive terraces are all much alike in their variable nature; but chiefly on the continuity and similarity of surface form and deposits, when traced horizontally in various districts; and on the systematic sequence of forms and deposits, when followed down from higher to lower levels. The plane, marked by the inner border of each terrace, must have been horizontal when formed, and is now faintly inclined to the southeast, as a result of slight inequality in later elevatory movements. The Talbot terrace, next preceding the present, has still a practically level inner border; the Sunderland terrace, having felt all the later changes of level, summarizes their inequality in a seaward slope of about three feet to a mile. Much more distinct than these extremely faint slopes is the manifest though still gentle descent of each terrace as it departs from its inner border at the scarp base towards the larger valleys with which it is related.

The maps that are bound in with the report give it excellent illustration. First is a general map of eastern Maryland (1,500,000), showing all the formations here described; and from this it appears clearly that, if the Lafayette and Sunderland ever existed (as they probably did) on the eastern peninsula of Maryland and Delaware—the 'Eastern Shore'—they were removed by successive attacks of subaerial and marine erosion, thus allowing the Wicómico terrace to spead over the axial upland of the peninsula as a broad plain, as yet but little dissected over its medial area. It is only on the group of dissected peninsulas between the Chesapeake and Potomac that the whole series of formations can be found, descending step-like from Lafayette on the uplands to Recent at the shore line. The inferred relations of land and water at successive epochs are even more clearly shown on a series of four smaller maps (20 miles to an inch), illustrating the supposed areas of submergence in Lafayette and later times. A final map indicates the inferred emergence of the land and the extended rivers of the Talbot-Recent interval of uplift. Numerous plates give views of the terrace deposits and of the scarps, recent and abandoned.

A brief review of certain points, on which this excellent report is not altogether clear at first reading, may now be presented.

1. As to the stage of erosion of the Cretaceous-Tertiary coastal plain, that had been reached when depression occurred and the deposition of the Lafayette commenced. It is said that "there was a long interval of erosion before deposition of the Lafayette beds began" (p. 78), and that "the Lafayette was developed as a plain surface sloping gently toward the surrounding waters" (p. 123); but the stage of erosion reached in pre-Lafayette time is not explicitly stated in physiographic

terms. However, the smoothness of the Lafayette plain, where it is still preserved, taken with the moderate thickness of its deposits (50 or 100 feet), would indicate that great advance had been made toward base-leveling by pre-Lafayette subaerial erosion; and that whatever residual relief then survived on the Cretaceous-Tertiary coastal plain area was effectually abraded by the advancing Lafayette sea. This conclusion evidently postulates the marine origin of the Lafayette, an origin generally accepted and not here brought into question.

2. The stage of erosion reached in the Lafayette-Sunderland interval of uplift. A comparison of statements in different chapters of the report and an examination of the relation between the several terrace scarps and the main valleys lead the reviewer to infer that the uplift of the renovated, or Lafayette-covered coastal plain was sufficient in amount and duration to allow its erosion by normal, river-led processes in the Lafayette-Sunderland interval to a stage of advanced maturity. The valleys thus formed seem to have compared well in width and depth, as stated above, with those of the Potomac and Chesapeake of the present day. The text of the report is, however, not immediately clear on this important point; and this is the more to be regretted, because a definite physiographic picture of the district at the beginning of the strong depression which culminated in the erosion of the Sunderland scarp is an essential basis for a clear understanding of the development of the several terraces. The difficulty here seems to be that the problem of the Lafayette-Sunderland interval is not completely stated on an early page, and then referred to, when occasion again arises, in the terms first adopted for its description; but that it is stated partially in different chapters, in various connections, and in diverse terminology, through all of which the reader must pursue his inquiry before he can acquire the writer's point of view. For example, after reading (as quoted above) that "there was a long interval of erosion before deposition of the Lafayette beds began," the following lines state that 'another long period of erosion occurred' before the Sunderland terrace was formed (p. 78). This would naturally give the impression that the Lafayette-Sunderland erosion interval was of great importance, for the pre-Lafayette erosion went far towards base-leveling the coastal plain of earlier uplift. On the other hand, in the final summary, the 'elevation and erosion' between the Lafayette and Sunderland formations is stated in precisely the same terms as the 'elevation and erosion' between each pair of the succeeding formations (p. 137); and inasmuch as the later erosion intervals are well proved to have been of moderate duration (as will be shown below), this would suggest that the Lafayette-Sunderland interval was also of no great length. The reader who glances, as some readers may, over the closing summary of the report before reading the details of the preceding pages, will naturally gain from the summary an impression that all the post-Lafayette erosion intervals were of about the same length. But this impression would have to be changed on further reading. For example, it is stated on an earlier page: "The salient features of the Coastal Plain topography were outlined at this time [Lafayette-Sunderland interval], although it is doubtful if they received their full strength or final touches before the post-Talbot uplift" (p. 123). This would indicate that the interval under discussion was long enough for the attainment of a mature stage of erosion; yet the next earlier sentence states: "After the deposition of the Lafayette formation, the land was raised above ocean-level and subjected to an interval of erosion which was probably of longer duration than the later ones which separated the other surficial deposits [terraces] of the series" (p. 123). Here the phrase, 'probably of longer duration' destroys all the emphasis that might be given to the duration of the Lafayette-Sunderland interval by the previous citation. Again, the statement that the Sunderland formation "extends up into ancient valleys which penetrate it [the Lafayette] as reentrants" (p. 87), coupled with the fact that these reentrants are shown by the general map to stand on the opposite sides of larger valleys,

five or ten miles wide, gives good ground for the inference that advanced maturity of erosion had been reached before Sunderland deposition began; and this inference is confirmed on reading a little later: "It is evident that the valleys of the Potomac, Patuxent and other large rivers as well as that of Chesapeake Bay existed [before Sunderland deposition], since the Sunderland formation, which was deposited when this topography was submerged, slopes toward all these depressions" (p. 123). Yet the next sentence baffles the reader by referring to the pre-Sunderland valleys as 'gorges,' a term which suggests something very different from valleys several miles wide and only a few hundred feet deep, with gentle lateral slopes of semi-consolidated formations, and which implies a relatively brief erosion interval. The reader's mind would surely be more easily made up regarding the writer's idea of the sequence of events, if the important Lafayette-Sunderland erosion interval had been once for all effectively described in technical language in an early chapter, and afterwards referred to when necessary in essentially the same language as that first employed.

The depth of the valleys eroded in the Lafayette-Sunderland interval is believed by Shattuck to have been less than that of the present valleys; but the evidence presented in favor of this conclusion does not seem to be positive. That valleys were present when the Sunderland terrace deposits were formed is shown by the fact that the deposits slope "from the watersheds of the peninsulas of southern Maryland toward Chesapeake Bay on the one hand and the estuaries of the Potomac and Patuxent rivers on the other" (p. 115). But it is concluded that no valley was cut so deep as it is now, because the Sunderland formation "nowhere shows a tendency to develop a thickness sufficient to fill such a valley" (p. 123; see also p. 135). The same is stated to be true of the other terraces (p. 135). It is not altogether safe for one who has but a slight acquaintance with the district under discussion to oppose this conclusion; yet the argument by which it is supported does not appear to be fully convincing. The comparatively brief duration of marine action at the several terrace levels would seem to be compatible with the deposition of most of the marine terrace sediments not far from the shore line, particularly in view of the belief that the scarps were presumably cut and the terraces built for the most part during a time of continued depression. Moreover, if the main valleys had been significantly deepened during the later inter-terrace intervals by normal subaerial agencies under the leadership of the larger rivers, the valleys must have also been greatly widened during the same intervals; and the time required for such widening —a slow process—seems inconsistent with the fairly good preservation of the first-made (Sunderland) scarp. This leads to a consideration of a third topic.

3. The duration of the interterrace intervals. The fact that the weathered Sunderland scarp is now recognizable at all requires that the entire duration of post-Sunderland time can not have been a large part of a physiographic cycle. Such a scarp, a minor feature at the best, would be entirely destroyed by general subaerial erosion in the passage of a coastal plain from the stage of late youth to that of early maturity, or from early maturity to late maturity. Hence only a short duration can be allowed to each of the three inter-terrace intervals of uplift and erosion, as well as to each of the three intervals of scarp-cutting and terrace-depositing. The author recognizes that these intervals are comparatively short, but he does not give sufficient emphasis to the contrast between their shortness and the much greater length of the Lafayette-Sunderland erosion interval. The work done in cutting scarps and depositing terraces is, however, very clearly presented; naturally so, as this is the chief theme of the report. The manner in which the later terrace deposits extend into the reentrants eroded in the margins of the earlier terrace deposits gives good proof that the post-Sunderland movements were oscillations; that is, repeated partial uplifts separated by slight depressions; and not merely pauses in a persistent uplift. The way in which the marine sands have come to overlie the fresh- or brackish-water bay-head clays is

admirably analyzed and illustrated. It is true that by no means all of the deposits which are treated as of marine origin are known to contain marine fossils; yet the localities where marine fossils have been found in them are held to be of demonstrating value for many others. With all these points in mind, one may picture very clearly the rapid succession of short-lived events during the Sunderland depression and the later oscillations. The advancing Sunderland sea presumably shaved off a film from the sinking surface; and the thickness of the film increased to a measure of fifty or more feet when the greatest encroachment of sea on land was made during the pause which closed the depression. In the following partial emergence, the sea presumably withdrew without doing recognizable erosive work —much in the way that the tool of a planing machine backs harmlessly across an iron plate, preparatory to taking off a shaving in its next advance. But the extended streams and rivers took advantage of the withdrawal of the sea and eroded new valleys in the margins of the revealed terraces. The advances of the sea in Wicómico and Talbot times repeated the operations of the Sunderland advance; and the recent advance, now in operation, gives the key to its predecessors.

The paleontological pages of the report show that the terraced coastal plain was a forested region during the time of its oscillations, with many trees like those of to-day; and that mammoths and elephants were among its inhabitants. Nearly all the marine forms are found living along the present coast.

Although this report is elaborated far beyond any previous descriptions of the Maryland coastal plain, there are certain features to which detailed studies may still be profitably directed in the future. There is, of course, a continual watch to be kept for new localities where sections of the various terraces may be exposed, and particularly where fossils may be found. All such discoveries will have high value in testing the correctness of the conclusions now set forth, inasmuch as the capacity of a theory reasonably to account for facts of later discovery is one of its best recommendations. Moreover, there are certain physiographic details to be filled in, which will give increased verisimilitude to the pictures of the Maryland Pleistocene already drawn. These details have regard to the contrasts that may be expected between the shore lines of the exposed ocean front and of the protected bay borders. For example: in Sunderland time, the peninsula of the Eastern Shore was completely submerged; the western border of what is now Chesapeake bay must then have been beaten with breakers from the ocean swell—except in so far as the swell was expended in passing over the shoals of the submerged Eastern Shore. The Sunderland scarp thus formed should have a different outline from the Wicomico, Talbot and Recent scarps, lower down the west Chesapeake slope; for when the latter scarps were formed, Chesapeake bay was enclosed from the ocean by the Eastern Shore peninsula, and its limited waves could not have trimmed a shore line of the same expression as that made by the ocean breakers. Similarly, the Talbot scarp cut in the Wicomico terrace on the eastern side of the Eastern Shore must have been cut by ocean breakers similar in force to those which have in Recent time formed the long, smooth-curved, off-shore sand reef by which Chincoteague and other 'bays' are enclosed along the present ocean front. Hence a similar off-shore sand reef might have been formed in a similar situation during the Talbot epoch. As no such Talbot sand reef is described, the reader is left somewhat in doubt as to whether it is really absent or whether exploration on the farther (eastern) slope of the Eastern Shore was not carried out in sufficient detail to determine it. Again, it is noted that the scarp and terrace of one epoch are occasionally undercut and entirely destroyed by the undercutting of the scarp of the next succeeding epoch; just as might be expected if the general slope of the attacked surface had been somewhat steeper in the later than in the earlier epoch. It will be interesting to learn if independent evidence is eventually found to show that such was the case. Finally, there are certain local features of special significance

found at a few points on the present shore line, such as the cuspate forelands seen at Cedar and Cove points on the lower Chesapeake; it will be edifying to learn if similar details are revealed by further study of the earlier shore lines. All these details concerning the shore line features might, it may be noted, have been stated to advantage in a technical terminology, as expressive of the precise quality of the facts as is the technical terminology that is employed without hesitation in the chapters on paleontology; but in the present volume the best technical terminology for the descriptions of shore lines—that suggested by Gulliver—is unfortunately seldom employed.

There is one reflection that Shattuck's close study of a coastal plain suggests to one who is particularly interested in that class of forms as objects of physiographic study; namely, the difficulty of telling the whole truth in a brief statement. It is customary with some physiographers to describe the coastal plain of the Maryland region as having been formerly maturely dissected and recently partly submerged; an effective general picture of its present form and outline is thus suggested in a few words. But the details of its form require a more elaborate statement for their proper presentation. It is a coastal plain which, having been uplifted and effectually baseleveled, was renovated with a wide-spread cover of Lafayette sediments, and then uplifted again, as good as new: in this condition it was dissected to well advanced maturity; then strongly submerged preparatory to an oscillating emergence, which allowed the rapid carving of four scarps and the deposition of four terraces (the last being those of to-day) on its maturely dissected slopes. The first brief statement will serve for use in schools; the second more elaborate account, with appropriate local details, may suffice for use in colleges. The features yet to be more fully investigated offer fitting subjects for field research by graduate students and professional workers.

W. M. DAVIS

SOCIETIES AND ACADEMIES

THE TEXAS ACADEMY OF SCIENCE

THE first meeting of the Texas Academy of Science for the year 1906–'07 was held in the chemical lecture room of the University of Texas on Friday evening, October 26, 1906. The program consisted of the inaugural address of the president, Dr. S. E. Mezes, professor of philosophy in the university and dean of the college of arts, who took for his subject 'What is Matter?'

At the regular meeting, November 24, 1906, Dr. George S. Fraps, of the Agricultural and Mechanical College of Texas, state chemist, discussed 'Food Adulteration' after which the speaker was entertained by the officers of the academy at an informal banquet.

The semi-annual formal meeting was held Tuesday evening, December 26, 1906. Dr. H. Y. Benedict, professor of applied mathematics and astronomy, in the University of Texas, delivered an illustrated lecture on 'The Solar System.'

At the regular meeting of January 26, 1907, Captain T. J. Dickson, chaplain of the 26th Infantry, U. S. A., Fort Sam Houston, San Antonio, by request, presented two illustrated papers: (1) 'Fighting Asiatic Cholera,' (2) 'The First Ascent of Mount Isarog'; both papers dealing with his personal experiences in the Philippine Islands.

The meeting for February–March was held March 7, 1907. Dr. Eugene P. Schoch, adjunct professor of chemistry, University of Texas, gave an experimental exhibition of 'The Transformation of Radium.'

Volume VIII. of the *Transactions of the Academy* has been recently published. Its contents include papers on the following subjects:

'The Æsthetic Element in Scientific Thought,' by Dr. Thomas Montgomery, Jr. This is the presidential address for 1905.

'Paving Brick,' by Thomas U. Taylor, dean of the department of engineering in the University of Texas.

'The Spacial Conception of the Blind,' by Dr. Franz J. Dohmen, honorary lecturer in mathematics in the University of Texas.

'Urogenital Organs of North American Lizards,' by Barney Brooks, professor of chemistry in Coronal Institute.

'The Indebtedness of the German Language to the Latin,' by Dr. Sylvester Primer, professor of Germanic languages in the University of Texas.

The volume concludes with the proceedings of the academy for 1905.

FREDERIC W. SIMONDS,
Secretary

UNIVERSITY OF TEXAS,
April 2, 1907

THE CHEMICAL SOCIETY OF WASHINGTON

THE 173d regular meeting of the Washington Section of the American Chemical Society was held at the Cosmos Club, March 14, 1907.

The question of a sanitary committee was settled by authorizing the president to instruct the committee on communications (O. Schreiner, chairman) "to make arrangements for special meetings of the society, or joint meetings with other organizations where lectures and reports may be presented on general or special phases of sanitation, in order that the society may be kept informed on such matters, and suitable action taken."

W. L. Dubois read a paper on 'Lactose and Butter Fat in Milk Chocolate' in which he showed that lactose could be accurately estimated by polarizing the solution of sugar at 86° after inversion, and butter-fat could be approximately determined by the Reichert-Meissl number of the extracted fat. Dr. A. Seidell presented a paper on the 'Determination of Acetanilid in Headache Powders.' The method suggested was based upon the reaction of bromine with anilin to form anilin tribromide. The sample containing acetanilid is dissolved in dilute hydrochloric acid and the solution boiled. Anilin hydrochloride thus formed is titrated directly with a standard solution of potassium bromate. The free bromine colors the solution yellow at the end of the reaction. W. T. Schaller presented a paper on 'The Chemical Composition of Molybdic Ocher' in which it was shown that the natural molybdic ocher is a hydrous ferric molybdate Fe_2O_3, $3MoO_3$, $7\frac{1}{2}H_2O$, and that the existence of molybdenum trioxide MoO_3 has not been demonstrated.

On April 1, Professor A. Frank, Jr., of Germany, gave an address before the society at the lecture hall of the George Washington University on 'The Utilization of Atmospheric Nitrogen in the Production of Calcium Cyanamid.' The speaker described the gradual steps which had been taken by various investigators during the past century to bring about the fixation of atmospheric nitrogen, and told of the successful accomplishment of this problem by his father working in collaboration with Dr. Caro. The successful issue of this task was made possible only after Professor Moissan had shown the practicability of manufacturing calcium carbide commercially, and after the introduction of the dynamo and electric oven by Siemens and Halske. The process consists essentially in passing a current of air freed from oxygen through calcium carbide heated in an electric oven, calcium cyanamid or lime-nitrogen being thus produced. The speaker also touched upon the fertilizing experiments carried on in Europe to show the value of cyanamid as a fertilizer. Other products are also produced, some being used in the manufacture of gun powder. Specimens of the various products were exhibited.

J. A. LE CLERC,
Secretary

BUREAU OF CHEMISTRY,
WASHINGTON, D. C.

DISCUSSION AND CORRESPONDENCE

THE FIRST SPECIES RULE AS IT AFFECTS GENERA OF NORTH AMERICAN BIRDS

IN my consideration of the application of the 'first species rule' in fixing the types of the genera of North American birds[1] I stated that fourteen changes in the genera of the A.O.U. Check List would result, while the types of several genera would be shifted to congeneric species. Dr. J. A. Allen has stated[2] that my statistics 'greatly underestimate the number of changes' and re-

[1] SCIENCE, XXIV., p. 262, November 2, 1906.
[2] SCIENCE, XXIV., p. 778, December 14, 1906.

cently[3] he has presented a list of twenty-one changes that he claims would be necessary.

It is well known to all that the first species and elimination methods are only used as methods of last resort; and cases where the author in the original publication has indicated a type do not come under the operation of either method. Four of Dr. Allen's alleged changes may thus be cancelled at once.

Spinus Koch, 1816, type *Fringilla spinus* L. by tautonomy.

Zonotrichia Swainson, 1831, types '*leucophrys, pennsylvanica, melodia*' designated by the author. We are bound to pick our type from these three 'typical' species and by either method *leucophrys* is the type and no change is required.

Poœcetes depends upon the last and falls with it.

Cyanurus Swains., 1831, is similarly restricted by the author to tropical species.

Colymbus Linn., 1758, does not come under the first species rule.

Erionetta Coues, 1884, is a monotypic genus and how it can become nameless by the operation of the first species rule I can not conceive. What does happen is that it is replaced by *Somateria,* the type of the latter being *Anas borealis* not by first species rule but because it is the only species definitely quoted.

One other case, *Aix,* I included among those in which the type shifted to a congeneric species, the A.O.U. committee having voted not to divide the genus *Aix.*

Removing these seven cases from Dr. Allen's list we have left fourteen, exactly the number I gave.

In my paper I claimed that fifteen changes would result from consistent elimination. Dr. Allen claims but three changes. I can not of course comment upon his results until the details of his eliminations are published.

In the eliminations of vulturine genera that he has published I called attention to several inconsistencies. One of these he now admits and changes the type of *Sarcorhamphus* from *auricularis* to *gryphus.* In his republication of the *Vultur* case, however, he makes another slip, forgetting that since *gryphus* is now the type of *Sarcorhamphus,* 1806, it must be removed from *Vultur* at that date, leaving *harpyia* or *papa* as the type of *Vultur,* the choice being a nice question of priority.

Sarcorhamphus thus replaces *Vultur* of Dr. Allen's scheme and *Vultur* will replace either *Harpyia* or *Gypagus.*

There seems to be only one alternative, *i. e.,* to remove *gryphus* at the date it became the type of *Sarcorhamphus.* If we do this, however, we must do the same with the other genera: *Aura* will go out at 1816, and *papa* at 1854, the latter being thus the type of *Vultur.*

This is an excellent illustration of the complexity of the elimination method and the opportunities it offers even to experts to fall into errors.

Dr. Allen's comments upon the points of my recent paper do not cause me to alter my statements and further discussion along those lines seems useless. The consideration of Linnæan names and priority of Swainson's papers are quite apart from the main issue.

WITMER STONE

ACADEMY NATURAL SCIENCES,
PHILADELPHIA, April 6

[3] SCIENCE, XXV., p. 552, April 5, 1907.

LACK OF RECUPERATIVE POWER OF ITALIAN WORKMEN

TO THE EDITOR OF SCIENCE: On reading Dr. Meltzer's most interesting paper in SCIENCE for March 29 I was reminded of a remark made to me some four or five years ago in regard to the lack of power of Italian workmen, in Italy, to recover from injuries. My informant had for many years been in charge, as foreman, of large numbers of Italian machinists and laborers (and of some English ones as well) in the Armstrong gun carriage and repair shops at Pozzuoli. In reviewing his impressions of the operatives he said that they were able to do fair days' work but that they were likely to be long ill or even to die from injuries that would not prove serious to an English workman. This he attributed wholly to the less substantial diet of the Italian. It is a noteworthy fact in this connection that the poorest Neapolitans set the subsistence limit at six *soldi, i. e.,* six cents,

per day. Meat is rarely eaten by any but well-to-do Neapolitans and the main sources of proteids are bread, spaghetti and beans (*Phaseolus*). It seems to me that in the lack of recuperative power shown by the Neapolitan workmen there is an excellent example of the danger of minimizing the reserve fund of proteids in the system, as suggested by Dr. Meltzer.

Joseph Y. Bergen

Cambridge, Mass.,
April 12, 1907

SPECIAL ARTICLES

GEOLOGY OF THE SIERRA ALMOLOYA, WITH NOTES ON THE TECTONIC HISTORY OF THE MEXICAN PLATEAU[1]

The Sierra Almoloya is situated in the southern part of the state of Chihuahua, about 25 miles west of Jimenez, and midway between the latter town and Parral.

This sierra is one of the numerous isolated mountain blocks of northern Mexico, like Santa Rosalia, Naica, Santa Eulalia and others, which rise in solitude from the vast area of surrounding arid plains constituting the great Chihuahua province, between eastern and western sierras, of the Mexican Plateau portion of the northern cordilleran region.

The mountain is a long and narrow range, about ten miles in length, extending in a northeast-southwest direction and averaging less than two miles in width. It is surrounded on every side by a lower area of sloping plain which has an altitude of about 5,000 feet at the mountain base. The total altitude of the mountain above the plain is fifteen hundred feet, the peaks rising to an altitude of 6,500 feet above the sea, as far as could be determined by a careful aneroid study. To the south of the range are several conspicuous outliers of lower altitude as shown upon the map.

The range is dominated by a narrow axial summit ridge, following the northeast-southwest trend of the mountains. Numerous narrow tongue-like salients radiate from the ridge to the plain, and separate by deep arroyos cutting back to the ridge ('capturing' it) and their valleys making great cirques, or amphitheaters between the salients.

Arising from the central ridge are several conspicuous summit peaks. The highest of these, attains an altitude of about 6,500 feet.

Like the other limestone mountains of the Chihuahua province, this sierra reveals the ancient wrinkled and folded structure of the plateau prior to when it was buried in vast beds of rhyolitic and andesitic volcanic ejecta which once covered this whole portion of Mexico, and which is still preserved in the western Sierra Madre, and like the other ranges mentioned the mountain represents the resistance and survival of the hardest, in the destructive atmospheric erosion and degradation of a once higher surface of the great western plateau.

The Sierra Almoloya is, therefore, a destructional or decadent form of a mountain, representing a remnant of the former extent of the rock material upward and laterally which fact is not only testified in the degraded shape of the mountain configuration itself, but by the vast quantities of talus and debris in process of forming on its surface and now filling the surrounding deserts.

Every detail of its relief such as its axial direction, the character of its slopes, the course of its lateral arroyos and other features are conformed to the arrangement or structure of the rock material composing the mountain, such as the lines of stratification, faults and folds, etc., to be later described.

The exposed rocks composing the sierra consist almost entirely of limestones of varying degrees of purity constituting the main mass and country rock of the mountain. Secondarily these are mineral ores and exceptional fragments of igneous rocks, the latter not found in place of origin.

The Limestones.—The mountain mass is composed of stratified limestones of the Comanche series of Lower Cretaceous age largely and mostly of the particular formation known as the Edwards limestone.

These limestones originated as sea muds in the form of chalk and chalk marls, accompanied by horizons of siliceous flint nodules,

[1] Read before the Geological Section of the New York Academy of Sciences, April 1, 1907.

when the Gulf of Mexico occupied this area. They now occur as gray, blue and black strata intensely hard, greatly altered, and in places converted into white crystalline marble and in others into a semi-schist. The individual beds of limestone vary in proportions of lime, silica and clay, and also slightly in color and texture.

These limestones have been greatly tilted and deformed in the various processes of mountain and continent building, so that instead of lying horizontal as they were originally deposited, they are tilted at every conceivable angle. They have also been folded into close folds. These folds are the most complicated I have ever seen in the rocks of this period, constituting what geologically may be termed thrusted overthrows, recumbent anticlines, etc., of the alpine type of structure.

When viewed from the plain from any direction, the mountain appears an elongated dome with the strata dipping conformable with the slopes in every direction from the central summit axis, so that as a whole it is quaquaversal in its character.

The western slopes of the mountain apparently consist of uniform beds of strata dipping towards the plain. On ascending and carefully studying the salients, it was found that the strata were folded directly back of one another in close compact recumbent folds, and that the dip of the folds corresponds with the ascent of the slope. Upon reaching the shoulder below the summit of Picacho the worn-off edges of the outer layers of the overthrown anticline project upward in great vertical strata.

The higher peaks and narrow connecting summit ridges with the exception of Mount Anticline, at the north end of the ranges, are all composed of the truncated vertical strata of the overturn of the recumbent anticlines. Not only are the rock sheets closely folded, but the folded edges are buckled, or bent, so that the buckling of the folds corresponds in its sinuous course to the axis of the mountain. The general strike of the old folds is north 30 east, north 50 east and north and south.

Had it not been for my previous familiarity with every detail of these Cretaceous rocks, as elsewhere studied, I doubt if the true structure would as yet have been ascertained. In fact, it was not until after many days upon the ground that I discovered, by the aid of the layers of flint nodules embedded in the limestone, how to trace the stratification beds in these greatly disturbed and altered strata.

Alteration.—In places near the acute flexures, the limestones are completely metamorphosed into white crystalline marble, or converted into schists—a fact which I have previously noticed in Mexico at Guaynopita, west of Chilpancingo and other localities. This phenomenon is so frequent as to lead to the inquiry if much of the pre-Cretaceous plexus of Mexico has not lost its integrity through the intense metamorphism of the post-Cretaceous mountain movements.

These limestones are also excessively fractured by several systems of joints, faults, etc. The bedding planes, which, when the strata are vertical, are also exceedingly difficult for the layman or even the geologist to distinguish, from the faults and joints.

In this mountain two distinct systems of faulting are discernible. The first system may be known as the north-south and northeast system, the other as the northwest fault system. The north 80° west faults are related to the northwest system in age.

The faulting and folding in north-south and northeast directions is an older structural feature than the other faults mentioned, and is apparently barren of mineralization. Faulting of this kind may be seen on the northeast side of the Picacho and the east side of Placeras and the west side of America.

Many of the north 40° west faults occur in parallel belts across the mountain range and nearly all the mineral outcrops seem to be closely associated with them.

The movements along the northwest faults has been lateral, displacing the older folds.

No igneous rocks outcrop on the Almoloya Mountains, or anywhere within a distance of ten or twelve miles, so far as I could ascertain. Fragments of rolled rhyolite occur in the talus along the west base of the mountain, and pieces of basalt are found in the Julietta

Valley. It is most probable, however, that the mountain is underlain at depth by igneous intrusions.

At the close of the Cretaceous period, at the time of the great Laranude or Rocky Mountain uplift, the sea bottom was uplifted into land, as a part of the Mexican Plateau province, and the rocks were wrinkled and compressed into the marvelous overthrown folds which they now present, having northeast and north-south trends.

This period of folding was that of the whole of the eastern Rocky Mountain region in north-south directions, and the union of the North and South American continents.

During the later epoch, probably the Miocene, the region and its limestone rocks underwent another orogenic movement, and was intruded from below by a vast igneous magma from which came dikes and ejecta of volcanic rocks which are now found throughout the region. Accompanying this epoch the whole structural or tectonic trend of the southern continent changed from a north-south to north 40° west course, and the north 40° west faults and folds of this later orogenic revolution were developed across the older north-south folds and faults, resulting in the development of the quaquaversal structure of northern Mexico, and I have seen it at La Mitra, Villadama and Candela, in the State of Coahuila, the Big and Little San Vincente, mountains crossed by the Rio Grande at Presidio San Vincente; at Guaynopita, Jesus Maria and Santa Rosalia, Mexico; and at Monument Mountain near El Paso, and in the Santragos Chinati and other mountains of Trans-Pews, Texas. The great mineral lodes of Mexico were mostly intruded, as hot vapors, waters and gases up these northwesterly fault zones.

Since or during this second epoch, the plateau as a whole has been uplifted, increasing the erosion, and the surface has worn down at least 2,000 feet. Some of the mineral contents have been washed away; others have concentrated down the fractures enriching the present ore bodies.

As the writer has previously shown, nearly all of the great ore localities of Mexico are associated with faults in this north 40° west direction. These faults are all of late geological origin, and probably the movements of the earth which made them are still going on, as testified by hot springs, in the vicinity.

By plotting the trends of the faults and folds of the Cordilleran region upon a large map, such as cannot be produced here, it certainly appears as if the northern part of the Mexican plateau province from the Colorado plateau southward through the northern tier of the States of Mexico has been the site of the crux of two distinct periods of mountain making movements, as illustrated in the Sierra Almoloya. One of these, and the older, has northerly trends representing the Laramide movements of the typical Rocky Mountain type, and the other having the northwestern trends of the Coast Range type, probably representing a post-Miocene revolution. The hypothesis of the crossing of these two belts of deformation explains many of the hitherto unexplained phenomena of our continent along the International Boundary and in Northern Mexico. It is certainly worthy of further test by field observation. Further study may show that the post-Miocene belt of northwest-southeast movement crossing the Laramide or Rocky Mountain north-south movement may extend from California across Mexico and connect with the Antillean movements of the West Indies.

Robert T. Hill

New York City

THE BIOLOGICAL LABORATORY OF THE U. S. BUREAU OF FISHERIES AT WOODS HOLE, MASS.[1]

Investigators and Assistants.—During the past laboratory season, thirty-two investigators were engaged in the study of various phases of marine biology, this number being somewhat larger than has been recorded for any summer within the last four years. Of these investigators, fourteen received a salary from the bureau, while eighteen are to be classed as volunteers. Thirteen junior assistants were also employed for various duties in the laboratory and in the field, two of whom, from the nature of part of their work, have like-

[1] Report of the work for the summer of 1906.

wise been included among the paid investigators. If we add to the foregoing, a librarian and a clerk, detailed from the Washington office, a collector, permanently employed at the Woods Hole Station, two temporary janitors and a chambermaid, we have forty-nine persons directly or indirectly engaged in the furtherance of scientific research. But the list would be quite incomplete without mention of the crews of the vessels *Fish Hawk, Phalarope* and *Blue Wing,* who of course rendered assistance of a most important kind.

Collecting.—The purchase of almost an entire new fish trap or pound was necessary at the commencement of the season. This was set, as usual, in Buzzards Bay, at a point not far from Woods Hole, and furnished much of the material used by those engaged in the study of fishes and their parasites. Visits were made from time to time to the extensive group of traps at Menemsha Bight, Marthas Vineyard, where material of value was obtained from the fishermen, who have always gladly cooperated with employes of the bureau in obtaining specimens of interest. Frequent trips were likewise made by the collecting vessels to various parts of Buzzards Bay and Vineyard Sound, and occasionally to more distant points. An unusually large amount of drifting *Sargassum* from the Gulf Stream was taken in Vineyard Sound, yielding abundant specimens of the extraordinary fishes, mollusks and crustaceans peculiar to the so-called 'gulf weed.' Finally, systematic shore collecting was carried on at various points, furnishing much material for research purposes as well as records for the biological survey.

Biological Survey.—Definite steps were taken toward bringing this project to a provisional close. No new areas of sea bottom were explored, though dredging was carried on at various points by the *Fish Hawk* for the purpose of verification and supplementation, and for the collection of bottom deposits. These last were submitted to Professor Gilbert van Ingen, of Princeton University, who has undertaken a study of the inorganic constituents of the local sea-floor. This, it is believed, may be of considerable importance in relation to the distribution of the bottom fauna and flora.

There remained considerable unidentified material among the collections of the preceding year, and these were sent to various taxonomic specialists, generally those who had previously done this work. It was found impossible, however, thus to dispose of two groups of great importance numerically, viz., the bryozoa and the amphipods. Accordingly, Dr. R. C. Osburn, of New York City, has undertaken the difficult task of reporting upon the former group; while Dr. Leon J. Cole, of Kingston, R. I., has assumed the equally burdensome task of identifying the amphipods. This latter undertaking is rendered peculiarly thankless, by the recent appearance of a fine monograph on the local amphipods by Professor S. J. Holmes.[1] The determination of our local bryozoa, on the other hand, may be almost regarded as pioneer work. The labors of Messrs. Osburn and Cole have been continued into the present winter, but it is planned that the lists shall be ready in time to allow of their inclusion in the projected report.

As above mentioned, systematic littoral collecting was conducted in a number of different places, along the shores of both Buzzards Bay and Vineyard Sound. It was not the object to keep thorough-going records of all species taken in each locality, as had been done in the case of the dredging stations. But it was thought desirable to extend the known distribution of certain species, for which few exact records are extant. It is to be hoped that ultimately the distribution of the littoral fauna of this region will be plotted out with the same minuteness as has been done for the bottom forms. The shore collecting was under the direct supervision of Messrs. Cole, Osburn and Sumner. The material collected has been sorted out and has been forwarded (or awaits forwarding) to various authorities. Dr. W. G. Van Name, of Springfield, Mass., has already reported upon the compound ascidians taken during

[1] 'The Amphipods of Southern New England,' Bulletin U. S. Bureau of Fisheries for 1904 (published in 1905), Vol. XXIV., pp. 457–529.

the past summer, as well as those of the two preceding summers. The other groups have been (or will be) referred to the authorities who have disposed of the dredging material of previous years; and reports are hoped for in time to be incorporated into the published report of the survey.

It is appropriate that mention should here be made of the loss sustained by the bureau in the death of Lieut. Franklin Swift, U.S.N., for two years commanding officer of the *Fish Hawk,* who died of typhoid fever at Charleston, S. C., on the tenth of November, 1906. Capt. Swift's knowledge of triangulation methods, derived from past experience in the Coast and Geodetic Survey, and from the recent work of the *Albatross* in Monterey Bay, made him an expert in that particular branch of navigation required in systematic dredging operations. The conscientious accuracy of his methods was felt by all of those who witnessed his work at Woods Hole.

Report upon the Work accomplished.—It has been thought desirable to bring the present biological survey to a provisional close, and to publish the results of the work already accomplished. With this in view, the present writer, who has directed the scientific work at the Woods Hole station for the past four summers, has been employed by the bureau to complete these results during the current winter; and a year's leave of absence from college teaching has been granted him for this purpose. A clerk has been detailed, and a scientific assistant appointed, in order to facilitate this undertaking. The work is now being carried out at Woods Hole.

Museum.—The formation of a representative collection of local marine animals was commenced many years ago, though the necessity for such a collection has not always received adequate recognition, and the existing specimens have suffered much from lack of attention. Dr. R. C. Osburn, as acting curator, has recently accomplished much in the way of reorganizing the local museum, and the extensive collecting operations of the past few years have provided much material. The museum now contains a fairly representative set of specimens which have been authoritatively identified by the various experts assisting in the determination of dredging material. It has been decided to fit up two large rooms upon the third floor of the laboratory building for the reception of these specimens. It is planned to make this a reference collection of local forms of life, rather than a public display of curiosities. Any one who has felt the need of identifying an unfamiliar species in the course of his biological investigations will realize the utility of such a museum.

Library.—The library has always proved to be an extremely important adjunct to this laboratory; and its use has not been restricted to investigators here, but has been extended to the whole scientific colony at Woods Hole. The contents of the library have been in part permanent, in part temporary. The permanent collection consists for the most part of government reports, and of separates donated by various authors. In addition to these, however, an extensive collection of standard biological works and periodicals have for a number of seasons past been loaned by the department of anatomy of Brown University. While greatly appreciating the privilege of using these books, it is felt by the Bureau of Fisheries that the Woods Hole laboratory should possess a permanent and fairly adequate working library of its own. It is the bureau's intention, therefore, to begin the purchase of the more necessary works as soon as funds are available for the purpose.

Individual Investigations.—Of the thirty-two investigators, nine represented Harvard University; four, Columbia; three each came from Yale University and the College of the City of New York, and two from Brown. The remainder represented thirteen different institutions in the east, west, north and south.[3]

For the purposes of the present synopsis, the

[3] In this computation each investigator has been accredited to the institution in which he had taught or studied *during the preceding academic year.* Two investigators have been referred to two institutions each. In the ensuing list, on the other hand, that institution has been named *to which* each investigator went at the close of the summer.

subjects of research may be rather arbitrarily classified as follows:

General physiology, reactions to stimuli and behavior	11
Taxonomy	7
Faunal distribution (including survey work)	6
Anatomy and histology	4
Regeneration	3
Embryology (including maturation of the egg)	3
Parasites of fishes	2
Economic, in narrower sense (not including the last)	2
Miscellaneous	5
Total	43

It must here be borne in mind that some investigators were concerned with more than one subject of research; likewise that in a few instances one subject of research has been included under two heads.

Mention may be appropriately made here of the visit of Sir Frederick Nicholson, of Madras, who was engaged in an investigation of American fisheries methods on behalf of the government of India, and who was the guest of the laboratory for several days.

List of Investigators

Carl L. Alsberg, A.M., M.D., instructor in biological chemistry, Harvard Medical School: The chemical composition of the blood of selachians.

Arthur M. Banta, A.M., Austin research fellow, Harvard University: The reactions of marine amphipods to light.

Robert P. Bigelow, Ph.D., instructor in biology, Massachusetts Institute of Technology: The Stomatopoda collected by the *Albatross*.

Wesley R. Coe, Ph.D., assistant professor of comparative anatomy, Yale University: Regeneration in nemerteans.

Leon J. Cole, Ph.D., chief of division of animal breeding and pathology, Agricultural Experiment Station, Kingston, R. I.: Collecting on behalf of biological survey; identification of local amphipods. (Salaried research assistant.)

Edgar D. Congdon, A.M., Austin teaching fellow of Harvard University: Pigment migration in the eyes of crustacea.

Joseph A. Cushman, assistant curator, Boston Society of Natural History: Systematic work upon local sponges, ostracods and foraminifera. (Salaried research assistant.)

Irving A. Field, professor of biology, Westminster College, Westminster, Md.: The food value of some hitherto unused or little used marine animals. (Salaried research assistant.)

Addison Gulick, A.M., graduate student in Harvard University: The histology and function of the osphradium in molluscs.

Chas. W. Hargitt, professor of zoology, Syracuse University: The anthozoa of the Woods Hole region. (Salaried research assistant.)

Geo. T. Hargitt, A.M., teacher of zoology, Syracuse High School, Syracuse, N. Y.: The effect of salt solutions upon regeneration and growth.

Davenport Hooker, student in Yale University, assisted Dr. W. R. Coe.

H. E. Jordan, A.M., fellow in zoology, Princeton University: Cytological studies of echinoderm eggs.

William E. Kellicott, Ph.D., professor of biology, Woman's College, Baltimore: Correlation of external and internal characters in certain fishes.

Beverly W. Kunkel, Ph.D., instructor in biology, Sheffield Scientific School, Yale University: Studies of amphipods and of teleost brains.

Edwin Linton, Ph.D., professor of biology, Washington and Jefferson College, Washington, Pa.: The entozoa of fishes. (Salaried research assistant.)

Jesse F. McClendon, Ph.D., Randolph-Macon College, Ashland, Va.: The development of parasitic copepods. (Salaried research assistant.)

Hanford McCurdy, A.M., Cleveland, Ohio: Hybridization experiments with echinoderms.

Charles V. Morrill, graduate student, Columbia University, assisted in the work of the biological survey; likewise was engaged in the study of regeneration in fishes. (Salaried assistant.)

Max Morse, tutor in natural history, Col-

lege of the City of New York, assisted in the work of the biological survey; likewise carried on studies upon the reactions of *Gonionemus*. (Salaried assistant.)

Edward Mueller, assistant in American Museum of Natural History, New York: Studies of Hydroids and sea-anemones.

R. C. Mullenix, graduate student, Harvard University: The caudal spinal nerves of elasmobranchs.

Raymond C. Osburn, Ph.D., teacher of zoology in the New York High School of Commerce: Collecting on behalf of the biological survey; identification of local bryozoa. (Salaried research assistant.)

George H. Parker, Ph.D., professor of zoology, Harvard University: The hearing of the weakfish, *Cynoscion regalis*. (Salaried research assistant.)

Herbert R. Sass, M.A., acting assistant in biology, College of Charleston: Factors influencing the distribution of littoral fauna.

George G. Scott, M.A., instructor in natural history; College of the City of New York: Experiments upon the regeneration of the fins of fishes; experiments upon the physiology of the blood of fishes. (Salaried assistant.)

H. D. Senior, M.B., associate in anatomy, Wistar Institute of Anatomy: The development of the blood vascular system of the teleosts.

Michael X. Sullivan, Ph.D., instructor in physiological chemistry, Brown University: The physiology of the digestive tract of elasmobranchs; the rectal gland of elasmobranchs; experiments to determine the effect of coal-tar contamination upon the health of fishes. (Salaried research assistant.)

Francis B. Sumner, Ph.D., director of the laboratory: Biological survey of local waters; the effects upon fishes of variations in the chemical and osmotic properties of the water.

Millett T. Thompson, Ph.D., assistant professor of zoology, Clark University: The masking habit and the food of the spider crabs.

Lloyd P. Upton, graduate student, Brown University: Physiology of nerve and muscle in the dogfish.

Gilbert van Ingen, Ph.D., assistant professor of geology, Princeton University: Examination of bottom deposits. (Salaried research assistant.)

Francis B. Sumner
Fisheries Laboratory, Woods Hole,
December 15, 1906

American Association of Museums

The second annual meeting of the American Association of Museums will be held in Pittsburg, June 4–6. The headquarters of the association will be at the Hotel Schenley. The first session will be held in the Carnegie Museum on Tuesday, June 4, at ten o'clock. A preliminary program will be issued about May 20. Titles of papers to be presented before the association should be sent as early as possible to Dr. W. J. Holland, Carnegie Museum, Pittsburg. All those interested in the objects of the association are invited to become members and to be present at the meeting. Fees for dues (two dollars for active members, ten dollars for sustaining members) may be sent direct to the treasurer, Dr. W. P. Wilson, the Philadelphia Museums, Philadelphia.

George A. Dorsey,
Secretary

The Smithsonian Institution and the National Academy of Sciences and the American Association for the Advancement of Science

In order to bring in closer touch the representative national scientific organizations of the country and the Smithsonian Institution at Washington, and to create a new channel for the diffusion of knowledge, Secretary Charles D. Walcott recently extended to the National Academy of Sciences and to the American Association for the Advancement of Science an invitation to make the Smithsonian Institution their headquarters.

The members of the National Academy of Sciences, Secretary Walcott invited "to deposit their archives, records, etc., in rooms provided for the purpose in the Smithsonian Institution, where the secretary of the academy could have access to them and attend to such business as might be necessary

in connection with the affairs of the academy." The secretary of the American Association for the Advancement of Science similarly was offered storage, office rooms and post-office facilities in the institution.

From Mr. Arnold Hague, home secretary of the National Academy of Sciences, the following communication has been received at the institution:

"At a meeting of the National Academy of Sciences held April 17, the secretary of the academy was requested to express to the secretary of the Smithsonian Institution the sincere thanks for the facilities afforded the academy during its sessions in Washington.

"The secretary was also requested to express the thanks of the academy for the room assigned to the academy for the use of its secretary and the keeping of the necessary files and papers, and also for the use of the members of the academy during their visits to Washington."

Dr. L. O. Howard, permanent secretary of the American Association for the Advancement of Science, has sent a letter of acceptance in the following form:

"The council of this association, at its spring meeting held in Washington on April 17, passed a formal and hearty vote of thanks to you for your great courtesy to the association in setting aside for its use storage and office rooms and a post-office box in the Smithsonian Institution."

By the location of the offices of these national scientific societies in the Smithsonian Institution, the institution becomes a clearing-house of national scientific learning. In this manner are forwarded the objects named in the will of James Smithson, the document by the terms of which the institution was founded, 'the increase and diffusion of knowledge among men.'

SCIENTIFIC NOTES AND NEWS

THE city council of Jena has given a plot of land, on which a philogenetic museum will be established in honor of Professor Ernst Heinrich Haeckel.

IN honor of Lord Lister's eightieth birthday the *Münchener medizinische Wochenschrift* has printed a German translation of his articles, containing the rudiments of the antiseptic theory as applied to the treatment of wounds, which began to appear in the *Lancet* of March 16, 1867.

PROFESSOR ADAM POLITZER will this year retire from the active duties of the chair of otology at the University of Vienna, and it is proposed to present to him a gold medal. Those who wish to take part in this testimonial and to secure copies of the medal should address Dr. G. Kaufmann, Vienna, VI., Mariahilferstrasse, 37.

M. DESLANDRES, of the Astrophysical Observatory at Meudon, has been elected president of the Astronomical Society of France.

AMBASSADOR BRYCE formally presented to Professor Ernest W. Brown, of Haverford College, the Royal Astronomical Society gold medal for 1907 (awarded last February), before the opening of the afternoon session of the American Philosophical Society, on Friday, April 19. Ambassador Charlemagne Tower and a large number of other members of the society and their friends were present.

PROFESSOR GEORGE L. MEYLAN, of Columbia University, has been elected president of the American Physical Education Association.

PRESIDENT IRA REMSEN, of the Johns Hopkins University, will make the principal address at the commencement exercises of the Michigan School of Mines.

MR. J. D. BOWMAN, secretary of the Carnegie Foundation for the Advancement of Teaching, has announced that, although the foundation has declined to admit state universities to the accepted list of beneficiaries of the fund, it occasionally grants retiring allowances to men in state institutions who have rendered distinguished academic service. In accordance with that plan the executive committee of the foundation has given retiring allowances to the following: E. Benjamin Andrews, chancellor of the University of Nebraska, who has been a prominent teacher and educator for thirty years. Francis H. Smith, for more than fifty years professor of natural philosophy at the University of Virginia. William V. Folwell, for fifteen years president

of the University of Minnesota and now professor of economics in that university. Amos N. Currier, for forty years professor of Latin and Greek in the University of Iowa and now dean of the college of liberal arts at that institution.

It is announced that the Lowell Observatory expedition to the Andes for the purpose of observing the apposition of Mars and the eclipse of the sun in July next will be in charge of Professor D. P. Todd, head of the astronomical department of Amherst College. He will be accompanied by Mrs. Todd, A. G. Illse, mechanician, and E. C. Slipher, of the Lowell Observatory, an expert photographer. The party will sail on May 11 for Colon.

Professor T. A. Jaggar, Jr., of the Massachusetts Institute of Technology, has gone to Alaska, where he will study the seismic and volcanic conditions.

Dr. George B. Gordon, of the Free Museum of Science and Art of the University of Pennsylvania, will this summer make an expedition to Alaska to make ethnological studies and collections.

Dr. Charles S. Prosser, professor of geology in Ohio State University, has a leave of absence during the present year, and has spent considerable time in comparing Ohio material with type or authentic specimens in Cornell and Columbia University museums, in the American Museum of Natural History and in the New York State Museum.

The University of Upsala will commemorate the bicentenary of the birth of Linnæus on May 23 and 24, and on May 25 the exercises will be continued at the Royal Academy of Sciences, Stockholm.

The botanical seminar of the University of Nebraska will celebrate the two hundredth anniversary of the birth of Linné (Linnæus) on the twenty-third of May, instead of the earlier date announced some time ago. The program includes an address by Dr. Roscoe Pound, a paper on 'Prelinnean Botany' by Dr. Clements, one by Dr. Bessey on the 'Position of Linné in Botany,' and one by Dr. Ward on 'Linné as a Zoologist and Physician.' Following the program there will be a convocation of the seminar at which the usual refreshments will be served.

New York University will unveil bronze tablets in honor of eleven Americans in the Hall of Fame on May 30, including memorials of Louis Agassiz and Maria Mitchell.

In memory of Pierre Curie a medallion is about to be placed in his laboratory in the Municipal School of Physics and Chemistry.

Dr. Carl Ludwig Rominger, the veteran paleontologist, and for fourteen years the state geologist of Michigan, died at his home at Ann Arbor, Michigan, on April 22, at the age of 86 years.

Dr. Franz Kjellman, professor of botany at Upsala University since 1883, has died at the age of sixty-one years.

Dr. Albert von Mosetig-Moorhof, professor of surgery in the University of Vienna, was drowned on April 26.

The collection of photographs and autograph letters of the members of the National Academy of Sciences since its organization, made by Dr. Marcus Benjamin, has been purchased by an anonymous donor and presented to the academy.

The tenth Congress of Polish Men of Science and Physicians will be held this year at Lemberg some time between June 16 and July 24. There will be a scientific and medico-hygienic exposition in connection with the congress.

The seventh International Congress of Physiologists will be held this year at Heidelberg, August 13–16, under the presidency of Professor A. Kossel. The previous congresses were held at Basle, in 1889; Liége, in 1892; Berne, in 1895; Cambridge, in 1898; Turin, in 1901, and Brussels, in 1904.

The New York Botanical Garden has arranged its course of spring lectures, to be delivered in the lecture hall of the museum building of the garden, Bronx Park, on Saturday afternoons, at four o'clock, as follows:

April 27—'The Life Story of a Tree,' by Dr. C. Stuart Gager.

May 4—'The Flowers of Trees and Shrubs Growing Wild near New York City,' by Dr. N. L. Britton.

May 11—'Jamaica: Its Flora, Scenery and Recent Disaster,' by Dr. M. A. Howe.

May 18—'Water Lilies and other Aquatic Plants; their Relation to Horticulture,' by Mr. G. V. Nash.

May 25—'The Influence of Vegetation in the Formation of Recent and Ancient Swamps,' by Dr. Arthur Hollick.

June 1—'Some Little-known Edible Fruits of the United States,' by Dr. H. H. Rusby.

In order to provide a method for viewing the collections of the garden under guidance, an aid will leave the front door of the museum building every week day afternoon at three o'clock, to escort all who may wish to accompany him. The routes will be as follows: Monday, Hemlock Forest and Herbaceous Garden; Tuesday, Pinetum; Wednesday, Fruticetum and North Meadows; Thursday, deciduous arboretum, nurseries, propagating houses; Friday, public conservatories; Saturday, museums.

Nature states that the Port Erin Biological Station has never been more fully used by workers in marine biology than during the present Easter vacation. From the last week in March onwards throughout April, systematic collecting at sea and investigations in the laboratory have been actively pursued by as many biologists as can be comfortably accommodated. During the first half of April ten to twelve investigators occupied seats in the laboratory, and about the middle of the month a dozen senior students came in addition. The researchers include Professor B. Moore (biochemistry), Dr. H. Roaf (physiology of crustacea), Mr. J. Pearson (cancer), Mr. R. D. Laurie (biometrics), Mr. W. J. Dakin (Pecten), Professor Herdman, Mr. Wollaston and Mr. Gunn, all from Liverpool University; Professor Hickson, Mr. Chaffers and Mr. Whitnall, from the Victoria University of Manchester; Mr. Unwin, from the University of Leeds; and Mr. Chadwick, the resident naturalist. Plankton collections, both surface and deep, are being taken periodically, at stated localities, over a limited area for statistical purposes, from the steam yacht *Ladybird,* and the usual sea-fish hatching and distribution of larval plaice is in progress.

WE learn from the *British Medical Journal* that the medico-historical collections of the 'Empress-Frederick House for Higher Medical Study' were recently opened. Professor Schjerning, Director-general of the Army Medical Department, was present, and the Prussian Ministry of Education, and the Imperial Board of Health sent delegates. Professor E. Hollander, to whose skill in collecting and special knowledge of medical history, the collection owes the greater part of its objects, made the opening speech. He pointed out the value of a historical collection for teaching purposes. It gives students the best insight into medicine and therapeutics of past ages, showing in what manner medical aid was carried out, and what were the notions entertained by doctors and laity as to the nature of disease. The collection was then inspected; it contains originals and copies of ancient apparatus, oil paintings, water colors, engravings, etc., state and municipal rescripts, coins, medals and many miscellaneous objects of interest. A special division of the collection has been set apart for sending on loan to other university towns.

UNIVERSITY AND EDUCATIONAL NEWS

MR. JOHN D. ROCKEFELLER has given to the University of Chicago land fronting the south side of Midway Plaisance, extending from Madison Avenue to Cottage Grove Avenue. This property is said to have been acquired by Mr. Rockefeller at a cost of $1,500,000 and to be now of considerably greater value.

WILLIAMS COLLEGE will receive $192,000 by the death of E. W. Currier.

IT is announced that a new physical laboratory will be erected at Princeton University through gifts whose source is not announced.

BY the recent death of Mrs. Eliza Orne Ropes at Salem, Mass., public bequests to various institutions, amounting to $1,500,000, made in trust by Mary Putnam Ropes, who died in 1903, were released. Of these Harvard will receive a bequest to endow the Nathaniel Ropes professorship of political economy. If, after the endowment of the professorship, any surplus remains it will go to the Peabody Museum of Archeology and Ethnology.

Mr. Theodore P. Shonts will provide Drake University of Des Moines with fifty service scholarships of $50 each.

Miss Anna T. Jeanes, of Philadelphia, has created an endowment fund of $1,000,000, the income from which is to be applied toward the maintenance and assistance of elementary schools for negroes in the southern states.

Mrs. Russell Sage has given $75,000 to the Syrian Protestant College in Beirut, Turkey.

Mr. Byron E. Walker has given his paleontological and geological collections and library to the University of Toronto.

The statute of limitations was held to bar the Catholic University of America from recovering $78,000 from John F. Waggaman, said to be due on notes executed to the late Thomas E. Waggaman.

It is said that the Louisiana State University will establish this year a medical department in New Orleans.

The hundredth anniversary of the birth of Ezra Cornell was celebrated at Cornell University on April 26 and 27. On the first day the exercises were held in the Armory, and were presided over by President Schurman; an address on behalf of the trustees by Mr. Andrew Carnegie, who was unable to be present through illness, was read; an address on behalf of the faculty was made by Dr. Andrew D. White, the first president of the university, and addresses were made on behalf of the alumni and students. On April 27 the new agricultural building was dedicated, and addresses were made by Governor Hughes, ex-Governor Batchelder, of New Hampshire, and Professor Liberty H. Bailey, dean of the College of Agriculture.

In connection with the Yale Summer School Professor Gregory, who is one of the directors of the Connecticut Geological Survey, has arranged to take a class of teachers to the various parts of the state, where the most typical formations are to be found, and will lecture in the field to the class.

It is said that the principalship of the University of Toronto has been offered to Dr. Robert A. Falconer, principal of Pine Hill College, Halifax.

Dr. John Scholte Nollen, professor of German in Indiana University, has been elected president of Lake Forest University, Lake Forest, Ill. He takes charge on June 20, 1907.

At the University of Wisconsin, Professor H. L. Russell has been elected dean of the College of Agriculture to succeed Dean W. A. Henry, who has resigned. Otis A. Gage, now of the faculty of Cornell University, has been appointed assistant professor of physics; A. N. Winchell, now of the Montana School of Mines, assistant professor of mineralogy and petrography, and C. H. Hawes, of Cambridge University, lecturer in anthropology. The following promotions have also been made: From associate professor to professor, E. C. Elliott, education; Victor Lenher, chemistry. From assistant professor to associate professor, D. H. Otis, animal nutrition. From instructor to assistant professor, W. F. Dearborn, education; R. H. Denniston, botany; C. J. Davis, hydraulic engineering; J. H. Vosskuehler, machine design; J. G. Moore, horticulture; C. A. Ocock, engineering.

Benjamin L. Miller, A.B. (Kansas), Ph.D. (Johns Hopkins), of the department of geology at Bryn Mawr College, has been appointed professor of geology at Lehigh University.

Dr. H. W. Stuart, of Lake Forest University, has been appointed assistant professor of philosophy, and Dr. George H. Sabine has been appointed instructor in philosophy at Stanford University.

Legh W. Reid, associate professor of mathematics in Haverford College, has been appointed professor of mathematics.

At Cornell University, Mr. R. P. Lay has been appointed instructor in experimental engineering, and Robertson Mathews in machine design.

Dr. Grimbert has been appointed to a newly-established chair of biological chemistry in the School of Pharmacy of the University of Paris.